

ELECTRICAL SAFETY ANALYZER
Model 270

OPERATOR'S MANUAL



BIO-TEK
INSTRUMENTS, INC.



Digitized by the Internet Archive
in 2025

https://archive.org/details/manualsplus_10696

BIO-TEK
ELECTRICAL SAFETY ANALYZER
MODEL 270

OPERATOR'S MANUAL

MANUAL PART NUMBER - 94035
REVISION C

FOR SERIAL NUMBERS 0001 AND UP

BIO-TEK INSTRUMENTS, INC.
HIGHLAND PARK, BOX 998
WINOOSKI, VT 05404-0998 U.S.A.

800-451-5172
802-655-4040

TELEX 94-0136 BIO TEK SHVT

ATTENTION MODEL 270 OWNERS!

1. Do not use the Model 270 on equipment connected to a patient. Certain tests will introduce dangerous leakage currents.
2. Do not use the Model 270 to test receptacles if patient-connected devices are operating on the same circuit.
3. Line voltage (through 300K ohms) is applied to the universal ECG jacks during "Lead Isolation" testing. Do not touch the jacks while this test is being performed.
4. If the "Power Line Ground to Neut" test is performed on a GFI protected circuit, the GFI may be tripped (by the 25mA DC test current used for resistance measurement).
5. Do not use the instrument at line voltages other than what it was designed for without consulting the factory. The line voltage select switch must be in the proper position for 115 or 230 voltage use.
6. When measuring the leakage current of a motorized instrument, do not abruptly reverse the polarity. Place the polarity switch in the OFF position until the motor has stopped, then move it to the desired position.
7. As described in Section 3.2, the power, ground, and polarity test lights are designed for use with single phase non-isolated 120 VAC power systems. While use at higher voltages or with different power system configurations will not damage the 270 circuits, the neon light read-out chart on page 11 will not necessarily be correct.

TABLE OF CONTENTS

1.0	INTRODUCTION.....	1
1.1	General.....	1
1.2	Applications.....	1
1.3	Testing Capabilities.....	1
1.4	Establishing Safety Standards.....	3
1.5	Record Keeping and Tagging.....	3
2.0	DESCRIPTION.....	4
2.1	Front Panel.....	4
2.2	Back Panel.....	6
2.3	Optional Equipment.....	7
2.4	Accessories.....	7
2.5	Optional Accessories.....	8
3.0	OPERATING INSTRUCTIONS.....	9
3.1	Systems Check - General.....	9
3.2	Receptacle Testing.....	11
3.3	Portable Device Testing.....	13
3.4	Testing Portable Devices Used in Isolated Power Areas...	19
3.5	Testing Permanently Wired Devices.....	19
3.6	Dual Lead Measurements.....	21
3.7	Measuring Leakage Current Through The Ground Wire.....	22
3.8	Testing Isolated Power Systems/GFIs.....	23
3.9	Testing Ground Fault Interruptors.....	26
4.0	THEORY OF OPERATION.....	28
4.1	Documentation.....	28
4.2	Function Selection.....	28
4.3	Autoranging Amplifier.....	28
4.4	Resistance Measurement.....	29
4.5	Insulation Test.....	29
4.6	Power Supply.....	29
4.7	AC Line Switching and Test Receptacle.....	29
4.8	ECG Leads Tests.....	29
5.0	SERVICE INFORMATION.....	34
6.0	SPECIFICATIONS.....	35
7.0	CALIBRATION PROCEDURE.....	37
	BLOCK DIAGRAM.....	B-1
	SCHEMATIC.....	S-1
	COMPONENT LAYOUT DIAGRAM.....	L-1
	PARTS LIST.....	P-1

1.0 INTRODUCTION

1.1 General

The Model 270 Electrical Safety Analyzer is a portable, solid state instrument designed to perform all routine tests to determine if electrical devices, conductive surfaces, and receptacles are electrically safe for use according to recognized national safety standards.

The Model 270 has an internal resistance that simulates the lowest impedance which the human body offers to electrical current flow. By simulating the human body, the 270 test results indicate the actual levels that would pass through the body if it were to offer a path for leakage currents.

The Model 270 Electrical Safety Analyzer is a precision device designed to make electrical safety testing uncomplicated and rapid. Simple rotary switch operation, with an auto-ranging display, makes data collection simple and accurate. Universal ECG jacks, for plugs and snaps, facilitate ECG testing. Other features which increase user efficiency include: compact size, self-check circuitry, modular design for discrete servicing and side pouch accessory storage.

1.2 Applications

The 270 provides precise data on various parameters that will determine if a device is electrically safe for use.

As a quality assurance test instrument, the Model 270 provides a means to test devices before they are placed in service. A wide range of testing capabilities help indicate if the device will be safe during normal operating conditions as well as under worst case conditions. In addition, certain electrical specifications can be tested according to the manufacturers specifications.

The 270, if incorporated into a routine safety program, will provide both immediate and long-term benefits. Electrical degradation of a device will become readily evident from records of test results obtained during each electrical safety survey; thus, instruments can be removed from service before they become an electrical hazard.

In addition, this data will be useful whenever additional purchases of equipment are being considered. By reviewing the amount of repair time required for a given instrument, along with its safety record, it can be decided if repurchasing is cost effective.

1.3 Testing Capabilities

The Model 270 is designed to perform tests recommended by the majority of nationally recognized agencies involved in issuing safety standards. (AAMI frequency response and load)

Receptacles

- .Determine the polarity of each receptacle;
- .Determine if each receptacle is grounded;
- .Determine if the metal face plate of the outlet is grounded;
- .Measure the potential differences and resistances between the grounding pole of one receptacle and the grounding pole of any other receptacle;
- .Measure the potential differences and resistances between the grounding pole of a receptacle on one branch circuit and the grounding poles of receptacles on a different branch circuit fed by the same distribution panel;
- .Measure the potential differences and resistances between the grounding pole of each receptacle and the grounding point that services them;
- .Automatically tests neutral to ground resistance of a receptacle.

Portable Devices

- .Measure the potential differences between a device's exposed conductive surfaces and the grounding point that services it;
- .Measure the resistance between a device's exposed conductive surfaces and chassis, and the grounding pin of the plug;
- .Automatically tests resistance of power conductors to ground. (Part of the systems check.)
- .Measure leakage currents from a device when it is:

grounded with normal polarity
grounded with reversed polarity
ungrounded with normal polarity
ungrounded with reversed polarity

*all the above configurations may also be performed with the open-neutral test.

Equipment With Leads

- .Measure leakage currents from isolated patient leads;
- .Measure the leakage currents from non-isolated patient leads;
- .Measure the leakage currents between leads;
- .Measure potential differences between leads;
- .Measure resistances between leads and exposed conductive surfaces;
- .Measure isolation of patient leads using 120 volts;
- .Measure combined lead leakage from all leads.

Fixed Equipment

- .Measure the potential difference between exposed conductive surfaces of fixed equipment serviced by the same distribution panel;
- .Measure the resistance between exposed conductive surfaces of fixed equipment and the grounding pole of a power receptacle

- serviced by the same distribution panel;
- .Measure the potential differences between exposed conductive surfaces of fixed equipment serviced by different distribution panels;
- .Measure the resistance between exposed conductive surfaces of fixed equipment serviced by different distribution panels;
- .Test for continuity of ground between each grounding point and the exposed conductive surfaces of fixed equipment it services;
- .Measure leakage currents from fixed equipment.

Conductive Surfaces

- .Measure the potential differences between the grounding pole of one of the receptacles and each exposed conductive surface;
- .Measure the resistance of the grounding cord servicing each exposed conductive surface;
- .Measure the potential difference between each conductive surface located in a given area;
- .Measure the resistance between each grounding point and the exposed conductive surface it services;
- .Measure the leakage currents from exposed conductive surfaces.

1.4 Establishing Safety Standards

Due to variation in acceptable standards presently being suggested and enforced by the various agencies, organizations, and institutions, this manual does not include suggested acceptable levels for each test procedure.

Each test should be performed in accordance with the test procedures presented in this manual, but refer to your safety programs specifications to determine if the results obtained are acceptable, or if the item tested should be repaired or replaced.

If you have questions concerning standards, write to the appropriate agency, or write to Bio-Tek Instruments for information, specifying the application and area of concern. Bio-Tek Instruments has a manual on safety testing and standards, available at a nominal cost.

1.5 Record Keeping and Tagging

Bio-Tek Instruments has a complete Record Keeping and Tagging System available that will fit into any program. Write or call the Sales Department, Bio-Tek Instruments, Inc., Highland Park, Box 998, Winooski, VT 05404-0998, 800-451-5172 for information.

2.0 DESCRIPTION

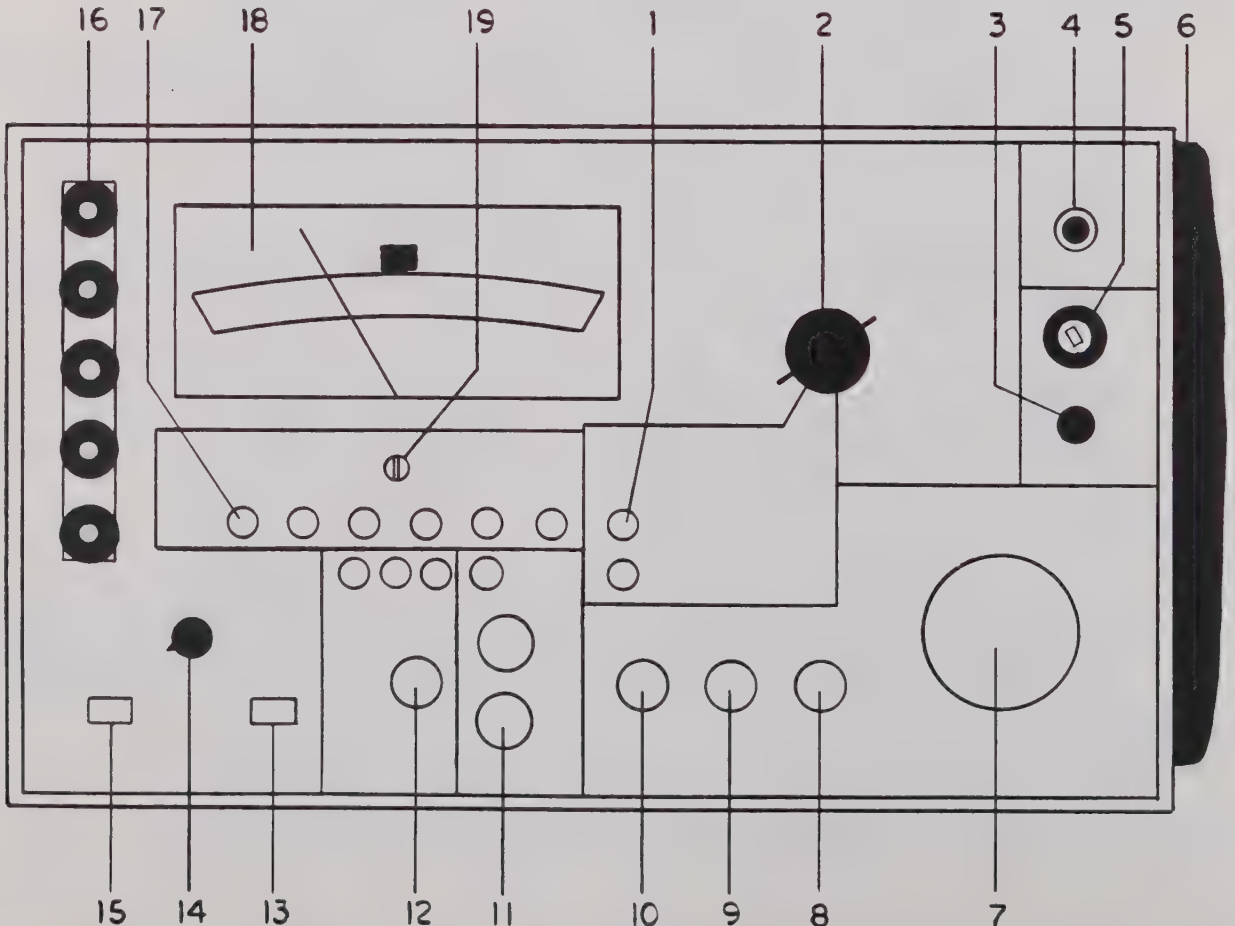
2.1 Front Panel

1. Systems Check - Concurrently performs the following tests.

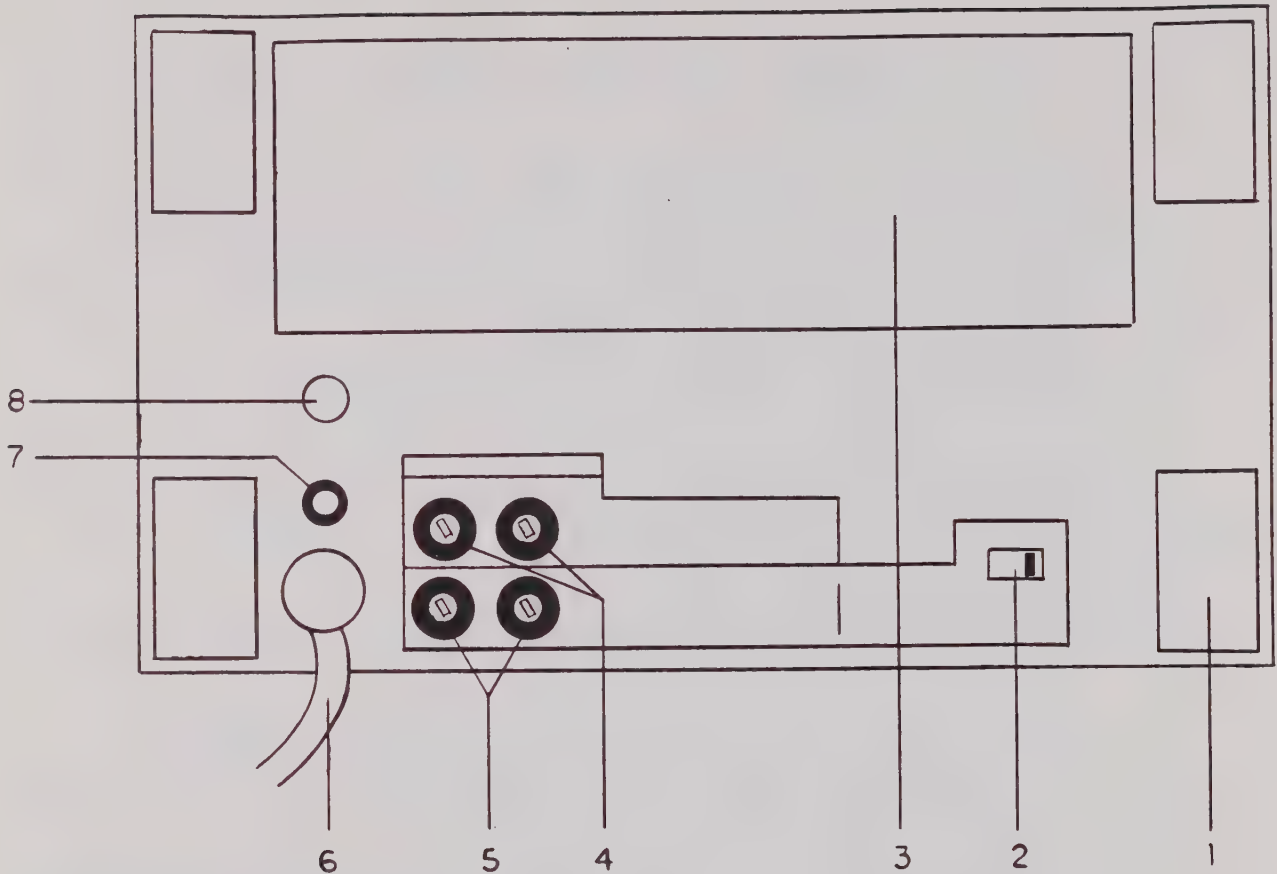
Insulation Test - Indicates whether the insulation of equipment's neutral/ground and power/ground is over 1 megohm.

Internal Calibration Test - 12.5mA reference. (For amplifier)
2. Function Selector - The selector controls the following tests: ECG leads leakage, Dual leads (uA), Chassis to red lead jack (uA), Ground wire to red lead jack (ohms), Dual leads (ohms), Power Line Ground to Neutral (ohms), equipment current (amps), Line voltage, AC/DC volts dual leads, Systems check.
3. Ohms Calibration - ohms zero pot.

MODEL 270 FRONT PANEL



4. AC Only - Filters out DC offset voltages from your measurements.
5. Fuse Holder - 0.1A fuse for ohms circuit protection.
6. Accessory Pouch - Holds all spare fuses and accessories.
7. Test Receptacle - Hospital grade receptacle brings test point to front panel.
8. Polarity Switch - Reverses polarity of Model 270 test receptacle.
9. Ground Switch - Simulates broken ground wire for device under test.
10. Open Neutral - Disconnects neutral power conductor at test receptacle.
11. Signal Inputs - The signal to be measured is applied between red and black inputs.
12. ON/OFF - Neon lights indicate wall receptacle polarity.
13. Lead Isolation - Momentary introduction of 120 volts through 300K limiting resistor.
14. Lead Select Control - Selects individual leads for individual lead leakage and isolation and between lead leakage.
15. Combined Lead Leakage - Shorts all individual lead leakage for combined reading.
16. Universal ECG Jacks - Allow attachment of ECG snaps or bananas. Color coded overlay.
17. Multiplier - Autoranging LEDs indicate measurement range.
18. Analog Meter Display - 4 inch meter, with two ranges, overload protection and $\pm 2\%$ accuracy.
19. Meter Adjustment - Mechanically zeros the analog meter.



2.2 Back Panel

1. Cord Wrap - Provides storage for the line cord and acts as feet for using the Model 270 on its back. In all four corners.
2. Line Voltage Select - Lets you select from 115/230 voltage use.
3. Short Form Instructions - Quick reference for showing how the Model 270 is used.
4. Fuse Holder - 15 amp fuses for front panel receptacle.
5. Fuse Holder - 1/4 amp fuses for Model 270 power supply.
6. Line Cord - Heavy duty line cord.
7. Front Panel Ground - Attached to the front panel's receptacle ground.
8. Chassis Ground Connector - Knurled nut provides easy connection to chassis of Model 270.

2.3 Optional Equipment

Most hospital operating rooms are equipped with explosion proof receptacles. Bio-Tek offers Adapter Cords to allow the Model 270 to effectively test these areas.

Model	Manufacturer
NF23/1. NF23/2	Hubbell

The "-1" units are equipped with a male explosion proof connector and a female three prong plug.

The "-2" units are equipped with female explosion proof type connector and a male three prong plug.

2.4 Accessories

The following accessories are provided with the Model 270. Part numbers are listed for use in ordering any extra accessories desired.

Large Clamp - 7770014
 1/4 Amp Fuse (2) - 46001
 15 Amp Fuse (2) - 46007
 1/10 Amp Fuse - 46019
 Ground Adapter - 48005
 Test Probe - 48031
 Black 5' Lead - 48032
 Red 5' Lead - 48033

International units have the following additional accessories.

10 Amp Fuse (2) - 46004
 0.5 Amp Fuse (2) - 46012
 International Fuse Carrier (4) - 46022
 International Fuse Carrier - 46018

2.5 Optional Accessories

Model CC3 Carrying Case

The Model CC3 is a custom carrying case designed to conveniently and safely transport your Model 270 and its accessories. The exterior is constructed of durable thermoplastic with a shock absorbent polyfoam interior.

This tough aluminum reinforced case comes with a full five year guarantee against all defects in materials and craftsmanship. Consult the current Bio-Tek price list for its price. Please note that when ordering the Model CC3, you state which instrument you are transporting in it.

Features:

- .Heavy duty ABS exterior
- .Shock absorbent polyfoam interior
- .Rugged steel-core handle and draw bit lock
- .All edges and corners reinforced with aluminum.

3.0 OPERATING INSTRUCTIONS

3.1 Systems Check - General

The Model 270's systems self-check insures the accuracy and operator's safety during your electrical safety testing. This should be done before each day's testing and upon connection to each new outlet.

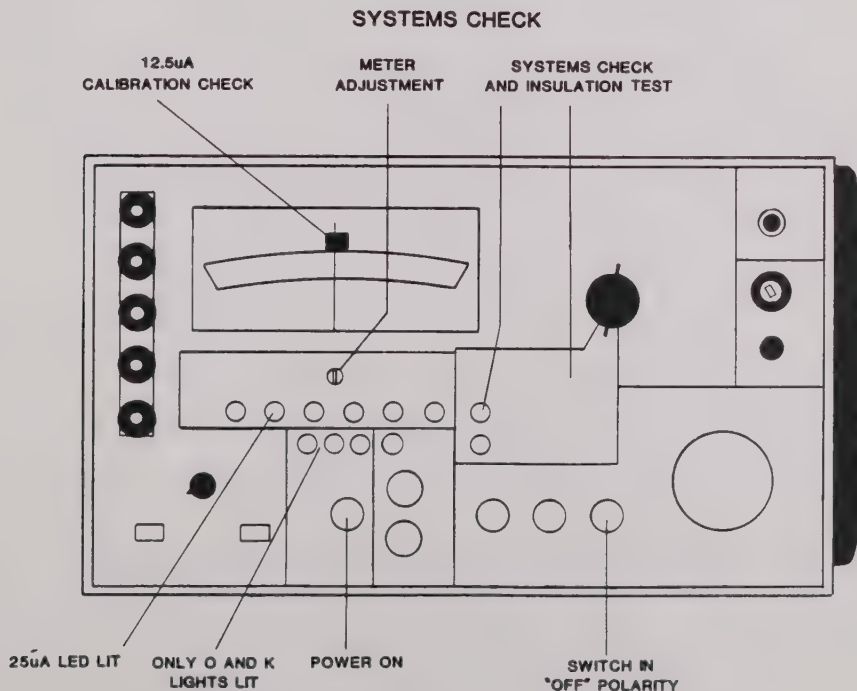
3.1.1 Systems Check - Specific

Plug the Model 270 into an outlet and plug the equipment under test into the Model 270. Turn the 270 on. Switch to Systems check. This will verify the following:

1. Analog display should read 12.5uA. This is controlled by an internal 12.5 reference. Insures calibration of Model 270.
2. Tests the receptacle to which the Model 270 is connected, for power, ground, and polarity.

NOTE: The receptacle test is invalid when in an Isolated Power System area. An explanation is contained in Section 3.2.

3. Insulation test is automatically done on power cord of equipment under test. This indicates whether power/ground and neutral ground resistance is over 1M ohm. Red LED indicates Failure; green LED indicates Pass. The polarity switch should be in the "OFF" position.



3.1.2 System Check Problem Analysis

1. Meter does not read 12.5uA.

- a. The meter may need to be mechanically adjusted. Turn the Model 270 off and mechanically adjust the pointer to zero using the set screw below the meter face.
- b. If the meter now reads out of the green band around 12.5uA, the unit may be malfunctioning or the meter movement may be damaged. It is recommended that the unit be returned to the factory at the address below.

Bio-Tek Instruments, Inc.
Service Department
Highland Park, Box 998
Winooski, VT 05404-0998

Return the unit prepaid and insured for full retail value.

2. One or both of the insulation check lights are red.

- a. Check to be sure that the polarity switch for the front receptacle is in the "OFF" position. If the receptacle is powered, the indicators will not work properly.
- b. Unplug the device under test. If the indicators are still red, the unit is probably defective and should be returned to the factory. If unplugging the device under test returns the lights to green, the device under test has an insulation failure which should be double checked with an ohm meter.

3. Neon lights indicate status other than proper "OK" configuration.

See Section 3.2 for analysis.

3.2 Receptacle Testing

The Model 270 allows comprehensive testing of ground referenced power system receptacles. Receptacles are tested for neutral to ground resistance, polarity, ground, and power. Resistances and potential differences between two receptacles can also be tested.

Note: Polarity testing and Neutral to Ground Resistance testing are not valid for an Isolated Power System (IPS). This is due to the fact that in an IPS there is no "hot" or "neutral" nor is either side of the power outlet connected to earth ground as in a conventional ground referenced power system.

1. Testing receptacles for power, ground, and polarity.
 - a. Plug the Model 270 into a receptacle.
 - b. Switch to "Systems Check".
 - c. The neon lights should read "O.K.". If not, refer to the neon light "Read-Out" chart below.

O	K	REV	
☐	☐	☐	NO POWER
☒	☒	☐	NORMAL POLARITY AND GROUND
☐	☐	☒	NO NEUTRAL, REVERSED POLARITY
☒	☐	☒	REVERSED POLARITY
☒	☐	☐	NO GROUND
☐	☒	☐	NO NEUTRAL

☐ - UNLIT
☒ - LIGHTED

2. Neutral to Ground Resistance Testing (Note: This test will trip ground fault interruptors. Do not perform this test on GFI protected receptacles.)
 - a. Plug the Model 270 into a receptacle to be tested.
 - b. Switch to "Dual Lead" ohms and short out the input jacks with the red lead provided.
 - c. Adjust the "ohms zero" knob until the meter reads "0".
 - d. Switch to "Power Line GND to NEUT".
 - e. The 1 ohm range LED should be lit.

APPLICATION NOTE:

OBSERVATION: Sometimes during the neutral to ground resistance testing the Bio-Tek Electrical Safety Analyzer(s) may give erratic readings.

During this test procedure the safety analyzer applies a fixed current (-10ma DC; -25ma DC; 10ma DC for 170, 270 and 501 Models respectively) between the neutral and ground wires. The resulting voltage drop due to the unknown resistance between the two wires is measured with an amplifier. A measure of this voltage drop is displayed by the analyzer as the resistance between the neutral and ground wires.

EXPLANATION: The amplifier circuit mentioned above also has a low pass filter that rejects 50 or 60 Hz, 100mv line interference. However, it is not unusual for much larger amplitude (several volts) signals, of 50/60 Hz or other frequencies, to be floating in the hospital wiring system. These interferences may be due to improper wiring, shielding, distribution system, or grounding. Ground loops and/or appliances and equipment (CAT Scanners, X-Ray equipment, etc.) used in the establishment may also contribute towards extraneous signal levels.

The low pass filters in the safety analyzers are not designed to eliminate the large signal interference described above. Thus the apparent voltage drop perceived by the safety analyzers' amplifier circuits will not be accurate, resulting in the erratic readings.

SOLUTION:

1. Perform the test with all other appliances and devices connected to the same distribution system unplugged.
2. If the erratic readings persist, you can make a choice between (a) ignoring and eliminating this test or (b) taking steps to have a better wiring, distribution and grounding system.

REMEMBER: THE NEUTRAL TO GROUND RESISTANCE TEST IS NOT REQUIRED BY ANY NATIONAL OR INTERNATIONAL STANDARDS.

3. Receptacle to Receptacle Testing of Resistance or Potential Difference.
 - a. Plug the Model 270 into a receptacle.
 - b. Switch to "Dual Lead" ohms. Short out input jacks with the red lead and zero meter.
 - c. Attach the ground adapter to a red lead. Remove the short across the input. Insert the red lead with adapter into red jack.
 - d. Plug the ground adapter into another receptacle.

- e. Put Ground switch on "NORM".
- f. Switch to "Ground Wire" ohms. The resistance between the receptacle that the Model 270 is plugged into and the receptacle with the red lead input is measured.
- g. By switching to "Dual Lead" uA, the potential difference in millivolts is measured.

4. Line Voltage

- a. Plug the Model 270 into wall receptacle.
- b. Switch to "Line Voltage" volts.
- c. Read Volts directly on meter.

3.3 Portable Device Testing

3.3.1 Introduction

This section describes how to test devices which have an accessible three prong, 15 amp plug. If the devices are permanently wired, refer to Section 3.5 for testing procedures.

3.3.2 Set-Up

1. Plug the Model 270 line cord into a receptacle.

NOTE: If the devices to be tested are located in an Isolated Power Systems Area, refer to Section 3.4 for set-up instructions.

2. Switch to "Systems Check". Verify that:

- a. Analog Meter reads 12.5uA.
- b. Power in neons read "OK".

NOTE: The receptacle test is invalid when testing in an Isolated Power System Area. An explanation is contained in Section 3.2.

- c. Insulation Test Indicators should be illuminated green.

If any of the above do not occur, refer to Section 3.1.2 for analysis.

3. Plug the line cord of the device under test into the 270 receptacle.
4. If the device has ECG leads, perform the following test prior to attaching these leads:
 - a. Switch to "ECG Leads" uA.

- b. Push "ECG Lead Isolation" button.

WARNING: The Universal ECG jacks have 120 volts through 300K applied when the ECG "Lead Isolation" button is pushed. Do not touch the jacks during measurement since current of up to 500 microamps can pass through the ECG jacks.

- c. Record the reading on the display (which should be between 1.0 and 10.0 microamps) on the inspection form as the "Isolation Factor". This reading should be subtracted from the ECG lead isolation measurements which will be made in Section 3.3.6.
5. If there are ECG leads, attach them to the Universal ECG Jacks by snapping them onto the top of the jack or by sliding the pins into the holes and screwing down the adapter nut.
 6. Connect the single red lead between the red input jack on the Model 270 and the chassis of the device under test. (Use the large clamp provided with the red lead if necessary.) No black lead is used.

3.3.3 Chassis Leakage Measurement

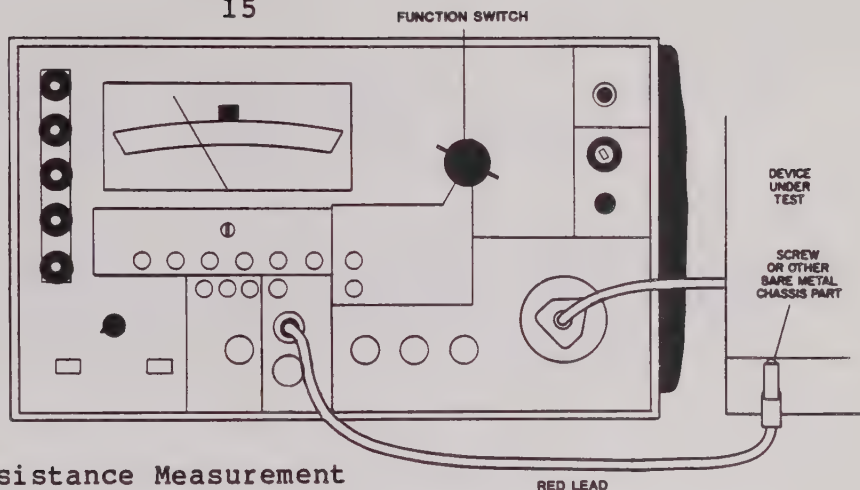
1. Switch to "Chassis" uA.
2. The display indicated leakage is in either microamps or millivolts. Take readings in each of the following power configurations:

- Normal Polarity - Ground
- Reversed Polarity - Ground
- Reversed Polarity - No Ground*
- Normal Polarity - No Ground*

Please Note: All tests can also be done with Open Neutral.

*If the "Danger" light is activated, place the polarity switch on center "OFF" position. Unplug the device, properly tag and remove from service.

3. The operator may wish to measure the separate A.C. and D.C. leakage current components. This can easily be accomplished by pressing the "A.C." button, in order to read only A.C. leakages. To obtain a D.C. leakage current reading, simply subtract the A.C. leakage current from the normal leakage current measurement.



3.3.4 Ground Wire Resistance Measurement

1. Place the "Polarity Switch" in the center "OFF" position.
2. Switch to "Ground Wire" ohms.
3. The analog meter reading indicates the resistance in ohms. Bend and manipulate the power cord of the device at the plug and grommet to see if there is an intermittent reading. If the meter reads overrange, the ground wire may be broken, or the device may be double insulated. Check the manufacturers literature to determine if the device is double insulated, in which case the ground wire resistance cannot be measured. Record this information on the inspection form.

If the device is not double insulated and the Model 270 reads "Overrange", the device is defective. Record the reading and tag accordingly.

3.3.5 ECG Lead Leakage Measurement

1. Switch to "ECG Leads" uA. (All ECG leads should be attached to the 270.)
2. Rotate the ECG lead selector switch to each position. Record the highest reading and the lead selected in each of the following power configurations:

Normal Polarity - Ground
 Reversed Polarity - Ground
 Reversed Polarity - No Ground
 Normal Polarity - No Ground

Please Note: All the tests can also be done with Open Neutral.

Note: The ECG Machine Selector Switch may be on any lead for all ECG Lead Leakage and Isolation Tests.

3. The operator may, upon his own discretion, use the "All Leads Leakage" selector, rather than test each individual lead. This will provide a cumulative figure of all the lead leakages.

NOTE: If the "Danger" light is activated put the polarity switch in center "OFF" position, disconnect the device and label accordingly. Discontinue testing.

3.3.6 ECG Lead Isolation Measurement

WARNING: During this test sequence, the line voltage (from a built in isolation transformer) through 300K ohms is applied to the universal ECG jacks. Do not touch these jacks when the "Lead Isolation" button is pushed.

1. Switch to "ECG Leads" uA.
2. Put the Polarity Switch on "NORM".
3. Put the ground switch on "NORM".*
4. Put the ECG selector switch on RL.
5. Push the ECG "Lead Isolation" button.

Record the reading minus the "270 Isolation Factor" measured in the set up procedure of Section 3.3.2, step 4.

If the 270 reads in excess of 300 microamperes, the ECG unit may not be isolated. Discontinue this test and refer to the ECG manual to determine isolation. Label the ECG unit accordingly (either "not isolated" or "defective").

6. Rotate the ECG selector to the next ECG lead and repeat step 5.

It is not necessary to record inter-lead isolation values.

*Ground Switch is on "NORM" to insure maximum leakage reading.

3.3.7 Current Consumption

1. Switch to "Equipment Current" amps.
2. Turn device under test on and read current draw directly in amps.

3.3.8 AAMI Reading Comparison

The standard for ECG isolation according to the Association for the Advancement of Medical Instrumentation is 20uA for ECG leads using 120 volts through a 120K ohms limiting resistor. The Model 270 uses a 300K ohm limiting resistor to provide operator safety. This results in different readings than those provided by the AAMI recommended technique. The isolation test current according to AAMI can be calculated from the current measured with the Model 270. A chart is also provided with equivalent AAMI readings. (See Chart 1 on page 17).

I_m = meter reading during isolation tests

V_{LA} = AAMI Test Voltage (120)

V_{LT} = Line voltage on which the 270 is being used - a transformer factor of 1.04 is present in the formula for added precision

I_f = isolation factor measured with no leads attached

I_{270} = 270 isolation leakage current

I_{AAMI} = AAMI isolation leakage current

$I_{270} = I_m - I_f$

$$I_{AAMI} = \frac{V_{LA}}{1.04 \cdot V_{LT}} \frac{I_{270}}{(1.8 \times 10^5) (I_{270})}$$

Example: When used at 120 volts, the "Lead Isolation" test button is pushed and the Model 270 reads: 5.0 with no leads attached (I_f) and 15.0 with leads attached (I_m), then $I_{270} = 15 - 5 = 10\mu A$.

$$10\mu A (I_{270}) = 1 \times 10^{-5} \text{ Amperes}$$

$$I_{AAMI} = \frac{(120) (1 \times 10^{-5})}{1.04 \times 120 - (1.8 \times 10^5) (1 \times 10^{-5})}$$

$$I_{AAMI} = \frac{120 \times 10^{-5}}{1.04 \times 120 - (1.8 \times 10^5) (1 \times 10^{-5})}$$

$$I_{AAMI} = \frac{120 \times 10^{-5}}{124.8 - 1.8}$$

$$I_{AAMI} = \frac{120 \times 10^{-5}}{123} = 0.975 \times 10^{-5} = 9.8\mu A$$

CHART 1

I_{270} @ 120V	I_{AAMI}
5.0	4.8
10	9.8
15	14.7
20	19.8
30	30.2
40	40.8
50	51.8
60	63.2
70	74.9
80	87.0
90	99.5
100	112.4
120	139.5
140	168.7
160	200.0
180	233.8
200	270.3

NOTE: In the range of importance, the differences are less than 5% which is within realistic measurement accuracies. I_{270} and I_{AAMI} can be considered equal below 30uA.

3.4 Testing Portable Devices Used in Isolated Power Areas

3.4.1 Introduction

It is recommended that devices used in areas with isolated power systems be tested in areas with a grounded (conventional) power system. The isolated power system (IPS) can decrease leakage current values substantially. In addition, leakage current standards are defined for grounded power system operation.

However, testing can be done either outside or inside the IPS area. Section 3.4.2 describes testing the devices using a grounded power system and Section 3.4.3 describes testing in the IPS area.

The optional adapter described in Section 2.3 are used to adapt the IPS special power connectors for use with the Model 270.

3.4.2 Testing IPS Devices on a Grounded Power System

1. Remove the device under test to an area with ground referenced power.
2. Plug the device into an adapter cord (Model NF23/2) with a female explosion-proof receptacle on one end of the adapter cord. Connect the other end of the adapter cord to the receptacle on the front panel of the Model 270.
3. Plug the Model 270 line cord into a wall receptacle.
4. The device can now be tested in accordance with Section 6.

3.4.3 Testing IPS Devices in the IPS Area

1. Connect the female explosion-proof receptacle of an adapter cord (Model NF23/2) to the male plug of the device under test.
2. Plug the other end of the adapter cord into the Model 270 test receptacle.
3. Plug a male explosion-proof plug from an adapter cord (Model NF23/1) into a receptacle in the IPS area.
4. Plug the line cord of the Model 270 into the female receptacle of the adapter cord of step 3.
5. Proceed as instructed in Section 3.3.

3.5 Testing Permanently Wired Devices

3.5.1 Introduction

The testing of permanently wired devices can be carried out only with the device under test either on or off. (This contrasts with portable units which can plug directly into the Model 270's front panel receptacle and have receptacle conditions varied by front

panel switching.) If an adapter cord is available proceed to step 3.5.2. If not, Section 3.6.

3.5.2 Single Lead Set-up

1. Attach the large clamp to the single red banana plug on the lead.
2. Plug the Model 270 line cord into a receptacle.

NOTE: If the devices to be tested are located in an Isolated Power System Area, refer to Section 3.4 for 1 through 4 set-up instructions.

3. Turn Model 270 on.
4. Switch to "Systems Check" 12.5. Verify that:
 - a. Analog display reads 12.5uA.
 - b. Power in neon light reads "OK".

NOTE: A. The receptacle test is invalid when testing in an Isolated Power Systems Area. An explanation is contained in Section 3.2.

B. The "Insulation" test is not valid for this test, since the device under test cannot be plugged into the Model 270.

5. Attach red clamp to chassis of device under test.
6. Switch to "Chassis" uA. Record the recordings with the device on and off.

NOTE: Readings will be virtually zero if device is well grounded.

7. Switch to "Ground Wire" ohms. Record reading in ohms (You may have to zero meter first. Refer to Section 3.2, step 2, part B).
8. If the device under test has no ECG leads, proceed to the next device. If the unit under test has ECG leads, proceed with step 10. (No ECG leads should be connected.)
9. Switch to "ECG Leads" uA. Push the "Lead Isolation" button.

WARNING: There is 120 volts on the universal ECG jacks during this test. Do not contact the jacks while the lead isolation button is depressed. Up to 500uA of leakage current may flow through the ECG jacks.

10. Record the meter reading with the ECG selector on RL. This leakage is internal to the Model 270 and should be subtracted from isolation readings taken in step 12.

11. Connect the ECG leads to the universal adapters by either snapping them on the top or sliding them in the hole and screwing down on them.
12. Push the "Lead Isolation" button with the ECG selector on RL. If the meter reads over 300uA, the unit is either not isolated or faulty. Read the ECG Service Manual and determine if the unit is isolated. If the unit is not isolated, proceed to step 14. (An isolation test cannot be performed on an unisolated device.) If the unit is isolated, remove from service and mark for repair. If meter reads less than 300uA, proceed to step 13.
13. Record the isolation leakage on each lead, with the "Lead Isolation" button pushed. Below 30 microamperes the Model 270 readings can be considered equal to values under AAMI standards. Above 30 microamperes refer to Chart 1, page 17 for conversion to AAMI test values. It is not necessary to record inter-lead isolation values.
14. Record the leakage current from each lead with "ECG Leads" uA function selected.

3.6 Dual Lead Measurements (Measurement Between Conductive Surfaces)

3.6.1 Introduction

The Model 270 can measure leakage currents, millivolt potentials, as well as resistances between any two points. These measurements are useful under the following circumstances:

1. Checking ground points in a room for point to point resistance and millivolt potentials.
2. Measuring leakage currents and ground wire resistances from devices with 220V or 110V power.
3. Measuring leakage current and ground wire resistances from devices in IPS areas without the use of adapter cords.
4. Making miscellaneous measurements independent of ground.

3.6.2 Set-Up

1. Connect the red lead to the red input jack. Connect the black lead to the black input jack.
2. Connect the appropriate adapters or probes to the other ends of the leads depending on type of measurement to be made.
3. Switch to the following functions for measurements indicated:

FUNCTION

MEASUREMENT

Dual Lead (ohms)

Resistance (ohms)

Dual Lead (uA)

Potential Difference
(millivolts)

Leakage Current (microamps)

The measurements are relative to the two points which the lead ends contact and are independent of earth ground.

3.7 Measuring Leakage Current Through The Ground Wire

3.7.1 Introduction

The Model 270 can measure leakage current through the ground wire, providing a quick way to spot check equipment. The readings obtained are identical to the readings that are obtained in Section 3.3.3 (Chassis Leakage Measurement) and can only be taken on portable devices that can be connected to the Model 270 receptacle.

It is recommended that this test not be used as routine inspection since chassis leakage from exposed metal is the desired measurement parameter. Also to properly test a device the ground wire resistance must be measured and to do this requires a lead to be connected to the chassis. The Model 270 is designed to take advantage of a one lead set up to make all measurements. However, for a quick spot checks, leakage current through the ground wire can be measured easily.

3.7.2 Set-Up

1. Plug the device to be tested into the Model 270 test receptacle.
2. Connect red lead from red input jack to the green "Front Panel Ground" jack on the back panel.

3.7.3 Measurement

1. Put the GROUND switch on "OPEN". This is necessary for any measurement in this section.
2. Switch to "Chassis" uA.
3. Change 270 receptacle conditions and take readings with the device ON/OFF with NORMAL and REVERSED polarity.

CAUTION: If the "Danger" light is activated, place the polarity switch on center "OFF" position. Unplug the device, properly tag and remove from service.

3.8 Testing Isolated Power Systems/GFIs

3.8.1 General

The Bio-Tek Model 270 when used with a Bio-Tek Universal Isotester can thoroughly test LIMs for the following:

Macro Fault - Measures the total leakage in the IPS unit on Line A or B. Macro Fault reads directly on the Model 270 from 0-25mA.

Trip Point - Tests the LIM's audible and/or visual alarm by simulating a variable fault to ground. Leakage to ground is taken from side A and B independently. Trip Point reads directly on the calibrated Universal Isotester.

Trip Point-Balanced - Tests the trip point of the LIM under simultaneous fault conditions. The fault current/resistance is varied simultaneously on both lines A and B. Allows calibration of LIM trip point. Reads directly on the calibrated Universal Isotester indicator.

3.8.2 Set-Up

1. Put the polarity and ground switch in normal position.
2. Plug the Universal Isotester into the front of the Model 270's receptacle and input jacks.
3. Connect the plug of the Model 270 to the appropriate adapter for connection to the isolated power system.

3.8.3 Operation

1. Switch to "Dual Leads" uA on the Model 270.
Note LIM meter reading for use in results.
2. Push the Macro Fault Side A button on the Universal Isotester.

Results: The Model 270 will indicate the total leakage to ground of the isolated power system. This reading should be approximately equal to the LIM meter indicator reading.

Requirements state that a LIM should not introduce greater than 1 miliamp of leakage to the system. Adding a factor for leakage due to wiring and devices connected could bring the Macro Fault up to 1.5 milliamps (1500uA).

3. Push the Macro Fault Side B button, the results should be the same as step 2.

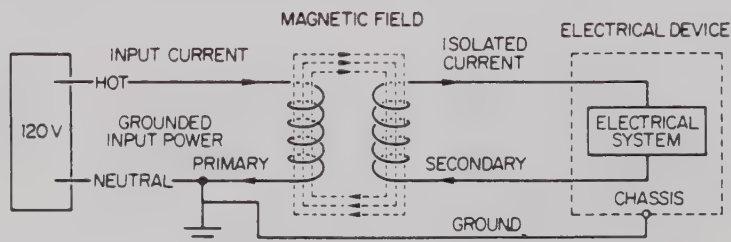
4. Rotate the Universal Isotester's Trip Point knob fully counter clockwise.
5. Push Trip Point A button. Rotate Universal Isotester's trip point knob back slowly clockwise.
6. Record the knob reading when the alarm sounds.
7. Push Opposite Wire Leakage button. The reading on the safety analyzer indicates the total leakage at the Trip Point. This reading should be approximately the knob indicated leakage, plus the macro fault leakage measured in step 2. Record the reading.
8. Repeat steps 4, 5, 6, and 7 with side B button pushed.
9. Push LIM trip point A + B. This simultaneously introduces a balanced fault on each line to ground. The reading should be similar to reading obtained in side A and B tests. This system can be used to calibrated the LIM trip point of the LIM.

Please Note: Isolated Power Test Forms may be ordered from Bio-Tek. Call Sales Department at 800-451-5172 for more information.

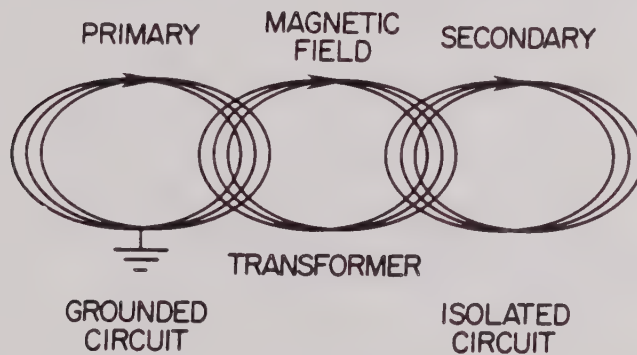
3.8.4 Isolated Power Systems

The isolation transformer functions to transform on earth referenced power distribution system into a non-earth referenced system. The voltage of either wire of an isolated power system, with respect to ground, is ideally zero. This means that a person standing with bare feet in six inches of water in the basement can touch either power conductor of an isolated power system, and not be injured.

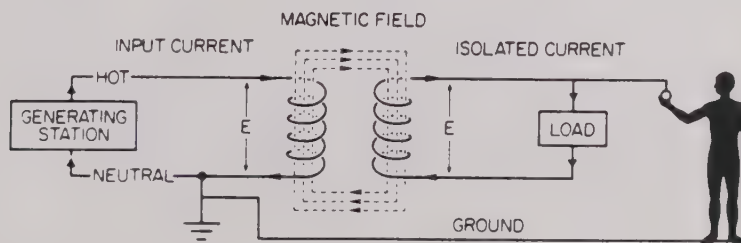
The theory of operation of an isolation transformer is based on transforming electric current flow into a magnetic field and the converting the field back into current. This process provides the isolation.



The grounded power system provides current which travels in a closed path through the primary of the transformer. This current creates a magnetic field in the transformer that also passes through the wires on the secondary. The magnetic field is a closed system that travel in a circular path. The current in the secondary of the transformer is also a closed path system. The net result is three circular systems that end up isolating two parts.



The basic principle of isolated power systems is that current must travel in a closed path. Using this principle, the following diagram indicates why a person doesn't receive a shock when connected to either power conductor.



There is no closed pathway for the current to flow through a person who is touching the wire. The transformer blocks the current from flowing around in a complete circle.

3.9 Testing Ground Fault Interruptors

3.9.1. General

The Universal Isotester option allows the Model 270 to thoroughly test Ground Fault Interruptors for actual trip points.

3.9.2 Set-Up

1. Attach Universal Isotester to the 270 (see section 3.8).
2. Plug Model 270 into the GFI under test.

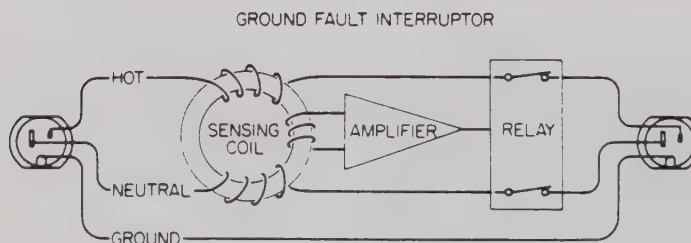
3.9.3 Operation

1. Turn Universal Isotester GFI Trip Point knob fully counter clockwise.
2. Turn GFI Trip Point knob slowly clockwise until GFI is tripped. Note knob reading and record.

3.9.4 Ground Fault Interrupters

Ground fault interrupters are automatic switches that disconnect the power if there is an excessive leakage current. Ground fault interrupter systems consist of a sensitive sensory system that controls switching relays.

The sensing circuit is not tied to ground. The ground fault interrupter uses a magnetic torroid around which several turns of the hot and neutral conductors are wrapped. The hot and neutral conductors are wrapped in the same direction. When current flows it produces a magnetic field. The current in the hot and neutral conductors travels in opposite directions. If the currents in hot and neutral are equal, which they should be, the net magnetic field is zero because the magnetic field produced by the hot wire is exactly cancelled by the magnetic field created by the current flowing in the opposite direction in the neutral wire.



Also wrapped around the magnetic core is a sensing winding. If the current in the hot and neutral is not equal, then there will be a net magnetic field that the sensing winding will detect. This is amplified and used to control the relays.

If the current in the hot and neutral conductor is not equal, then some current must be going to ground via another route. The neutral is the correct return path for the current. If it is not returning via the neutral, it is returning to ground through a conductive medium such as a human being.

4.0 THEORY OF OPERATION

4.1 Documentation - The documentation supplied within this manual includes:

- a. Block diagram (Page B-1)
- b. Assembly Interconnection diagram (Page 33)
- c. Schematics (Page S-1)
- d. Component placement diagrams (Page L-1)
- e. Parts list (Page P-1)
- f. Function chart (Page 32)
- g. ECG lead leakage and isolation functional diagrams (Pages 30 and 31).

A brief description of each section shown on the block diagram (Page B-1) and their relationship to one another follows: to relate the components shown on the schematics, the assembly interconnection diagram, and component placement diagrams should prove helpful.

4.2 Function Selection (2700028-SC page S-8 and function chart, Page 32).

The function selector switch on the front panel connects the appropriate inputs to the desired amplifier (ie. autoranging RMS or ohms) and creates logic level signals that affect the operation of several other blocks. The function chart will answer such questions as: which functions are autoranging; which scales are available; and which signals are used as inputs for each function. Some of the abbreviations used in the chart and on the schematics are:

Power Line Hot	PLH
Power Line Neutral	PLN
Power Line Ground	PLG
Receptacle Hot	RCH
Receptacle Neutral	RCN
Receptacle Ground	RCG
Red Input Jack	RED
Black Input Jack	BLK

4.3 Autoranging Amplifier

The voltmeter consists of an autoranging true RMS millivoltmeter having a high input impedance but always connected to measure the voltage drop across a standard AAMI load (Page 30). This millivoltmeter has three input sensitivities: 0-25mV, 0-250mV, and 0-2500mV. The autoranging feature is disabled for certain functions. The amplifier consists of U13, U18, U14, and associated components on schematic 2700010-SC, page 1. U13 has a fixed gain of 10, U18 is a unity gain buffer, and U14 is the RMS

to DC converter. On this same page of the schematic, U10 is the meter amplifier used to drive the 0-1mA meter. 250mV at TP2 causes a full scale deflection. The input to U13 can be divided by 10 (RY3) or by 100 (RY2) under control of the autoranging circuit. The autoranging circuit (2700010-SC, page 2) uses the output of U13 to control RY2 and RY3. Also in conjunction with the function switch selection, it controls the meter range scale LEDs, or can be forced to keep both relays open (1 SET signal).

When power line voltages are being measured a resistor/capacitor pair is switched in by the function switch to create a 10:1 voltage divider with the AAMI load.

When equipment current (current in the receptacle's neutral lead) is being measured, the millivoltmeter receives its input from a 0.001 ohm resistance in the neutral lead.

4.4 Resistance Measurement (ohms amplifier)

To make resistance measurements, a -25mA DC current source is applied to the unknown resistance and the resulting voltage drop is measured with an amplifier that rejects 50 or 60Hz interference. On schematics 2700010-SC, page 3; U10 and Q1 act as a current source, and U11 is the amplifier and low pass filter. The various diodes are for protection against the inadvertant application of line voltages to the ohms circuits.

4.5 Insulation Test

If the SYSTEMS CHECK function is selected, the insulation measuring circuit (2700010-SC, page 4) is activated. Two separate comparators have been adjusted to determine if the H to G (or N to G) resistance of the front panel receptacle is greater or less than one megohm. For proper operation the POLARITY switch must be in the OFF position.

4.6 Power Supply

Page 5 of schematic 2700010-SC shows the power supply for the 270. It provides ± 7.5 VDC (nominal) and a 2.5VDC reference. The tolerances are shown on the schematic.

4.7 AC Line Switching and Test Receptacle

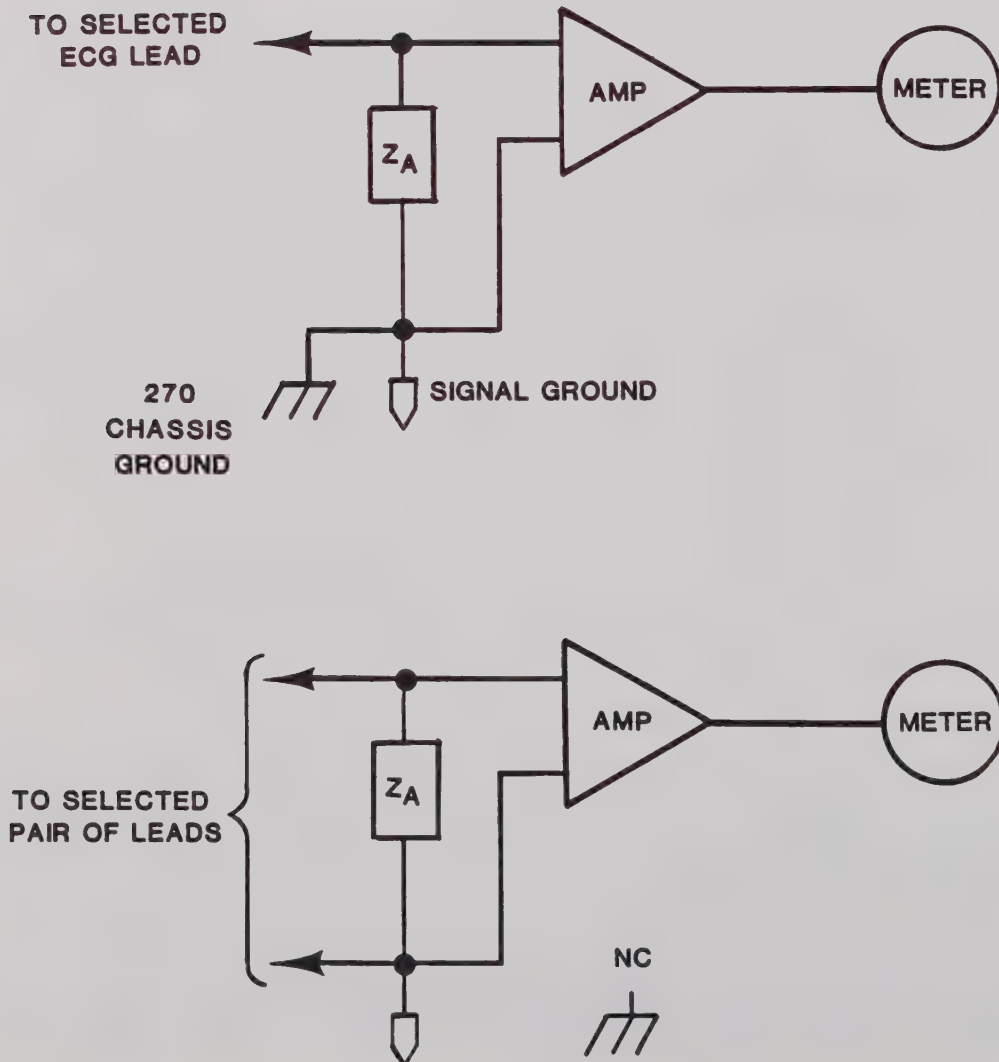
The 270 allows the operator to change the A.C. power line configuration to the device under test. The test receptacle is connected to the A.C. supply line by toggle switches which alter the polarity and open the ground or neutral leads to the test receptacle.

4.8 ECG Leads Tests

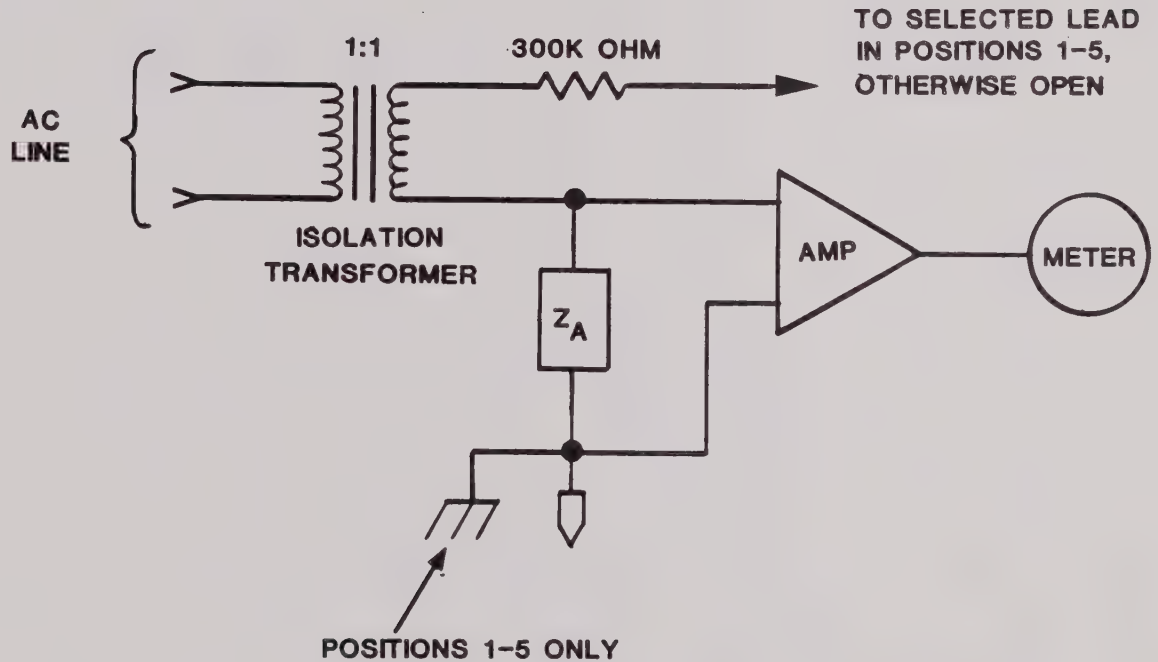
When the ECG LEADS function is selected the ECG Lead Select switch, LEAD ISOLATION pushbutton, the ALL LEADS CONNECTED

pushbutton and the five universal ECG posts become active. The test configuration is illustrated on pages 29 and 30. The amplifier is the RMS millivoltmeter, and Z_A is the AAMI load. The formula for calculating leakage at various line voltages is given in the operating instructions.

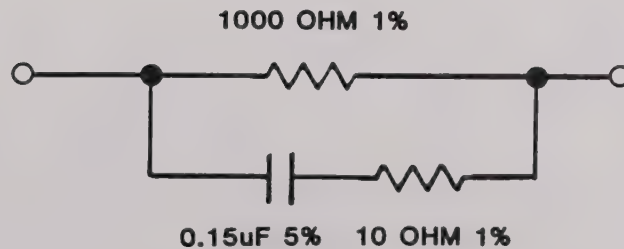
ECG LEAD LEAKAGE FUNCTIONAL DIAGRAM



ECG LEAD ISOLATION FUNCTIONAL DIAGRAM



AAMI LOAD CIRCUIT (Z_A)

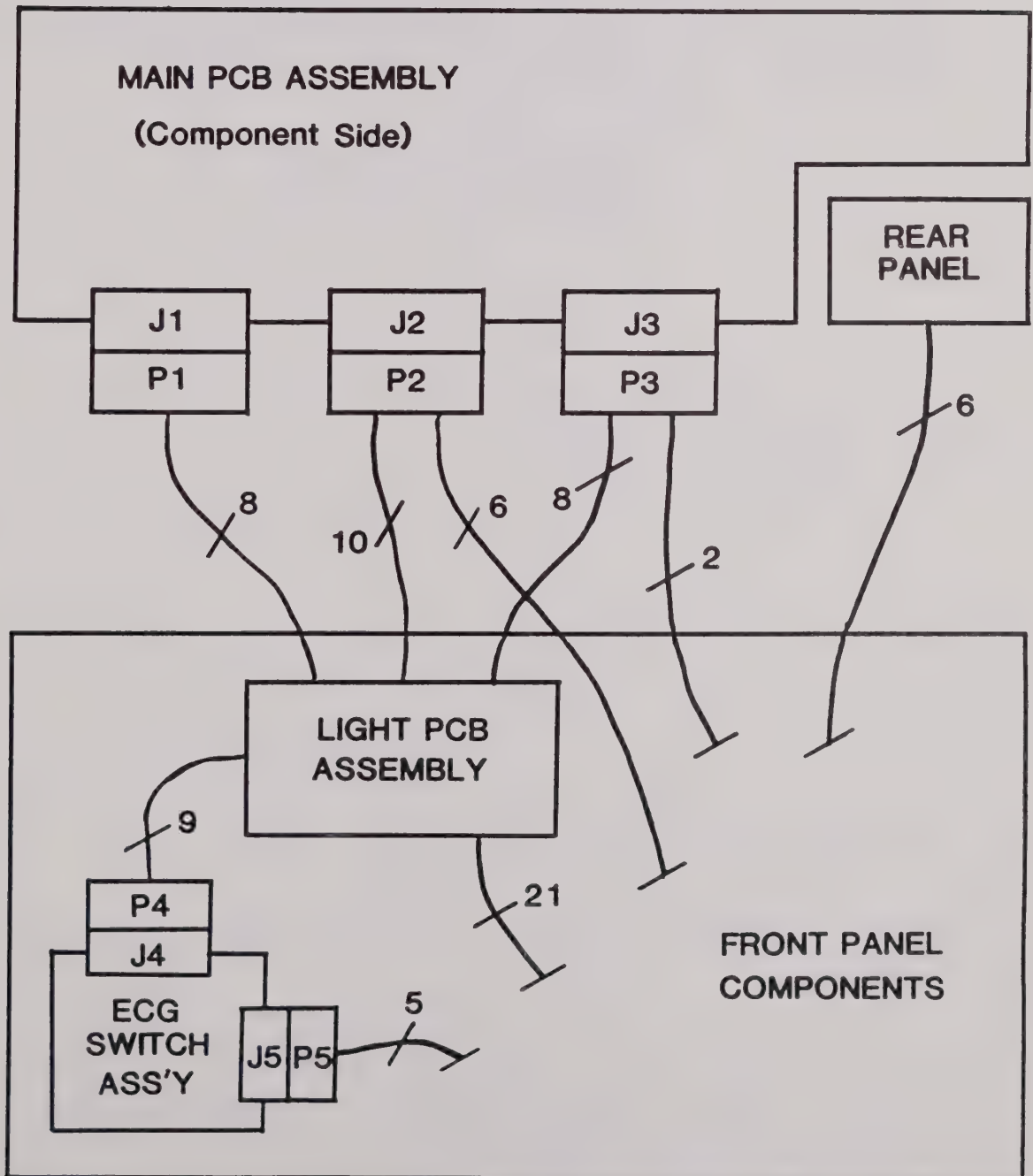


Switch Position	TEST NAME AND DESCRIPTION	Input Signal	Signal Return	AMPLIFIER SELECTED		CHECK IF NO CONNECTION		AUTO RANGE OR FIXED	SCALE LIGHTS	UNITS	* ¹ 	COMMENTS/NOTES	AAMI LOAD IN CIRCUIT?
				"OHMS"	"RMS"	Red	Black						
1	SYSTEMS CHECK & INSULATION TEST	INTERNAL 12.5mV	RCG		X	X	X	Fixed X1	0-25	μA or mV	YES	Receptical H and N are tested for resistance to G	YES
2	ECG LEADS Leakage & Isolation	ECG+	ECG-		X	X	X	Auto	0-25 0-250 0-2500	μA or mV	 see note	Inputs from ECG assembly depends on selection	YES
3	DUAL LEAD Leakage - Red to Black	Red	Blk		X			Auto	0-25 0-250 0-2500	μA or mV	NO		YES
4	CHASSIS Leakage - Red to Power Line Ground	Red	PLG		X		X	Auto	0-25 0-250 0-2500	μA or mV	YES		YES
5	GROUND WIRE Resistance - Red to Receptical Ground	Red	RCG	X			X	Fixed X1	0-1	Ω	YES	25 mA DC Source is connected	* ²
6	DUAL LEAD Resistance - Red to Black	Red	Blk	X				Fixed X1	0-1	Ω	NO	25 mA DC Source is connected	* ²
7	POWER LINE GROUND TO NEUTRAL Resistance	PLN	PLG	X		X	X	Fixed X1	0-1	Ω	YES	25mA DC Source is connected	* ²
8	EQUIPMENT CURRENT Current in Receptical Neutral Line	N"	N'		X	X	X	Fixed X1	0-25	A	NO	Series Resistance in N lead ≈ 1m Ω	* ²
9	LINE VOLTAGE (Power Line)	PLH via 100K	PLN		X	X	X	Auto	0-2.5 0-25 0-250	V	NO	10:1 divider on Input, Input Z > 100k Ω	* ²
10	DUAL LEAD Voltage - Red to Black	Red via 100K	Blk		X			Auto	0-2.5 0-25 0-250	V	NO	10:1 divider on Input, Input Z > 100k Ω	* ²

*¹ Is signal return connected to chassis ground?*² AAMI load is present but not effective because of circuit configuration.

MODEL 270

ASSEMBLY INTERCONNECTIONS



5.0 SERVICE INFORMATION

The 270 may be serviced by users knowledgeable in electronic repair. Refer to the Theory of Operation, schematic, block diagram, component layout diagram, and parts list in this manual. We recommend that the 270 be recalibrated annually. Calibration instructions are in Section 7.0. If the purchaser does not possess the necessary equipment for proper recalibration, return the 270 to the factory, prepaid with a purchase order for recalibration traceable to the National Bureau of Standards. For recalibration or further service, pack the unit carefully, insure for the full retail value, and ship by U.P.S. to:

Service Department
Bio-Tek Instruments, Inc.
Highland Park, Box 998
Winooski, VT 05404-0998
800-451-5172

6.0 SPECIFICATIONS

Leakage Current

Microamps/Millivolts (through AAMI test load): 0-25, 0-250, 0-2500uA.

Accuracy: $\pm 2\%$ of full scale.

Millivolts: 0-25, 0-250, 0-2500mV.

Accuracy: $\pm 2\%$ of full scale.

Input Impedance: per AAMI test load (see Page 30).

Frequency Response: DC to 80KHz (+0, -3dB).

Current

Amperes: 0-20A (rated range).

Accuracy: $\pm 2\%$ of full scale.

Automatic Insulation Test: Pass/Fail LEDs, indicate acceptable neutral/ground and power/ground resistances (for equipment under test). Standards are based on $>$ or $<$ megohm.

Accuracy: $\pm 15\%$

Volts

Volts Range: 0-2.5, 0-25, 0-250.

Accuracy: $\pm 2\%$ of full scale.

ECG Lead Leakage/Isolation

Leakage Current: 0-25, 0-250, 0-2500uA.

Lead Isolation: Line voltage through 300K ohm limiting resistor.

Current Carrying Capability: 15 amps @ 120 volts, 10 amps @ 220 volts.

Open Neutral Test: to UL544 Requirements.

Display: 4-1/2" precision analog meter, full one year warranty

Power Requirements: 95V to 130V 50/60Hz or 200V to 240V
50/60Hz switch selectable on rear panel.

Systems Check:

Calibration: 12.5uA source

Receptacle: Power, Ground, and Polarity verification of wall receptacle.

Insulation Test: Automatic LED indication of equipment's power/ground, neutral/ground insulation. Standard is > 1 megohm.

Resistance: 1 ohm calibration standard (test done in resistance operating mode).

Physical Characteristics

Case: 11 x 6.5 x 4.5" (279 x 165 x 114mm) electrostatic epoxy finish

Weight: 7.5 lbs. (1.8 kg)

Carrying Case: Model CC3, ABS plastic with 5 year warranty.

Environment: Operating Temperature: 0° - 40° C;
Storage Temperature: -25° - 50° C;
Humidity to 90% R.H.

Accessories: Large probe, clamp, ground adapter, 2 x 5' lead, spare fuses, two instruction manuals.

Warranty: Full warranty on all parts and labor (see warranty card for elaboration).

Calibration: Traceable to the National Bureau of Standards (NBS). Recommended recalibration once a year. Send unit to:

Service Department
Bio-Tek Instruments, Inc.
Highland Park, Box 998
Winooski, VT 05404-0998
800-451-5172

7.0 CALIBRATION PROCEDURE

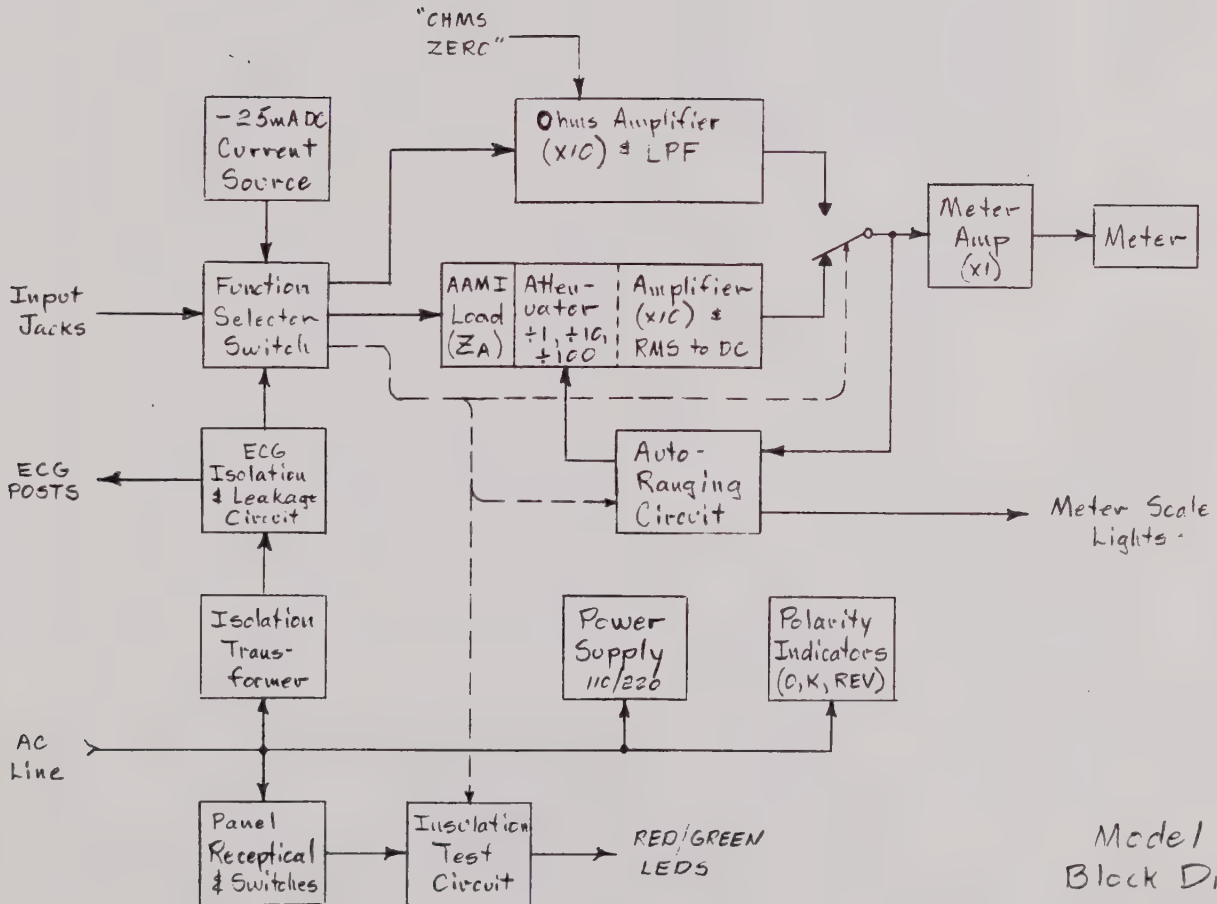
1. Short out the input jacks with either a shorting bar or run one of the leads from the red jack to the black jack.
2. Switch the Model 270 function switch to the "Dual Leads" μ A position. Connect a DVM between TP1 and TPGND. Adjust R7 to obtain a minimum DVM reading. Now place DVM between TP2 and TPGND. Adjust R81 to obtain a minimum DVM reading. (DVM should be set on DC mV.)
3. Remove the shorting bar and apply 25mVDC to the input jacks. Adjust R4 for a 250mV reading at TP2. Now adjust R77 for a full scale meter reading (25).
4. Apply 25.5mVDC to the input jacks and adjust R25 until the meter shifts into the next range (250mV). Lower your input voltage to 20mVDC. Adjust R24 to the point where the meter shifts back into the next lower range (25mV).
5. Now apply 250 and then 2500mVDC to the input jacks. The meter should read $\pm 2\%$. (R17 adjusts the 250mV range and R18 adjusts the 2500mV range.)
6. Switch function switch to "Dual Leads" volts. Apply 25V DC and note the Model 270 meter reads 25V and is in the 25 range. Switch the function switch to the "Line Voltage" volts position. Note that the Model 270 reads line voltage.
7. Switch function switch to the "Systems Check" positions. Assure that the polarity switch is in the "OFF" position. Apply a 1 meg ohm resistor between the Hot and Ground of the test receptacle on the Model 270. Adjust R70 until the "Hot to Chassis" LED is pink. Move the 1 meg ohm resistor to the Neutral and Ground pins on the Model 270. Adjust R69 until the "Neutral to Chassis" LED is pink. Also note that the Model 270's analog meter is reading 12.5 μ A (in the green area on the meter).
8. Switch the 270 to the "Dual Leads" ohms position. Short the input jacks on the model 270. Set R52 (zero ohms pot) to its maximum CW end. Adjust R54 to read a -50mV on the DVM. (DVM leads are between TP2 and TPGND.) Now rotate R52 to its maximum CCW end and observe the DVM should read between +250mV and +500mV. Now adjust R52 to obtain a 0 reading on the Model 270's analog meter. Remove the short from the input jacks and place a 1 ohm 1% resistor across the input jacks. The Model 270 should read 1 ohms.

Assemble the 270 into its case.

1. Make provisions to reverse polarity and break ground on power going to the 270. Assure that the receptacle check lights work properly when unit is turned on.

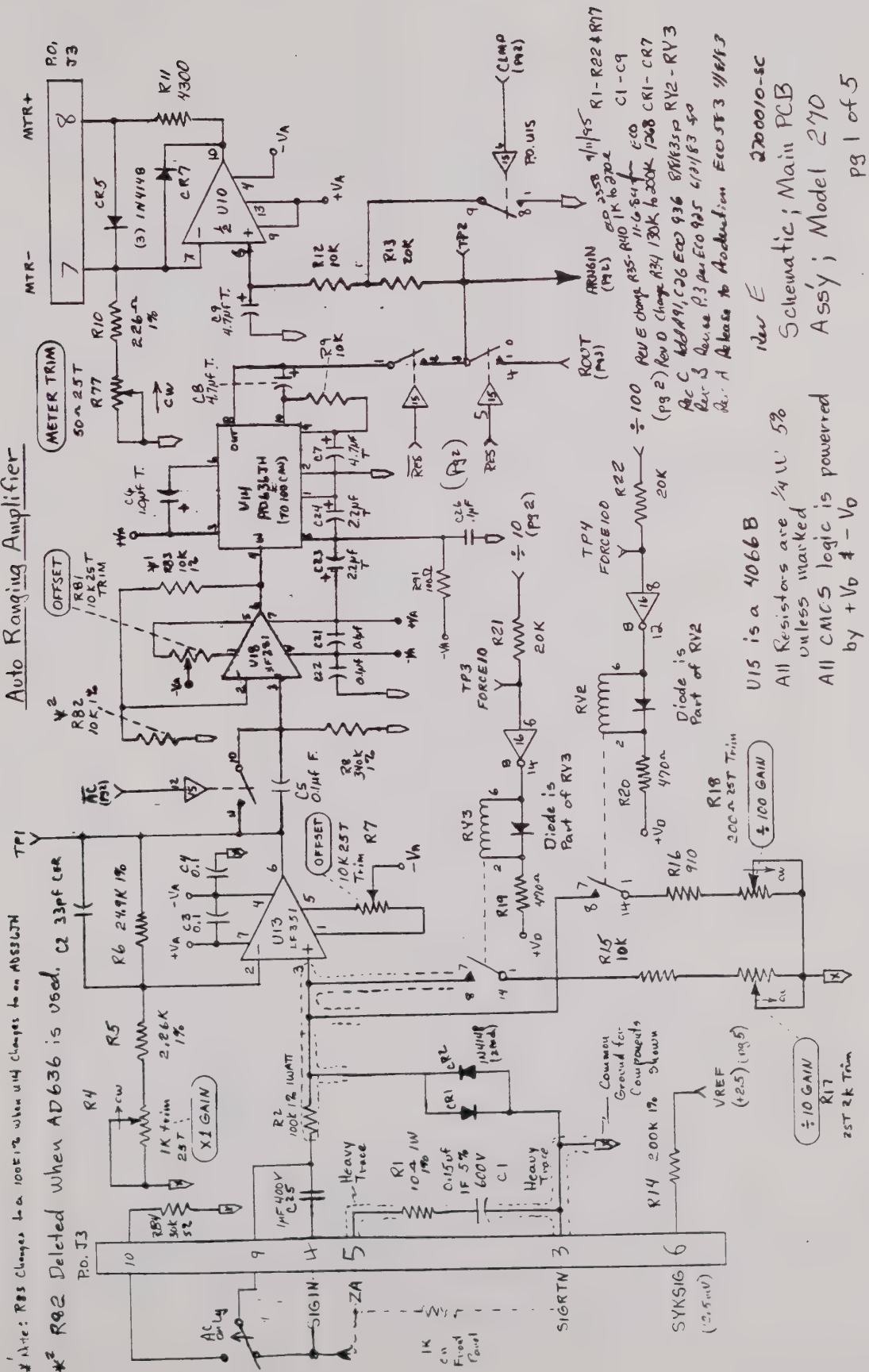
2. Plug receptacle tester into test receptacle on 270 and assure that the Normal-Off-Reverse, Open Neutral, and Open Ground switches on the 270 are working properly.
3. Switch to "Equipment Current" uA and make provision to draw a known amount of current from 270 test receptacle. Assure that the 270 reads the proper amount of current ($\pm 3\%$ of full scale).
4. Switch to "ECG Leads" uA. Apply 1.0V DC between RA and ground, RL and ground, LL and ground, and C/V and ground. Push "Lead Isolation" button and rotate "ECG Lead Select" switch through RA, LA, RL, LL, AND C. 270 should read 1000uA ± 30 uA on all settings.

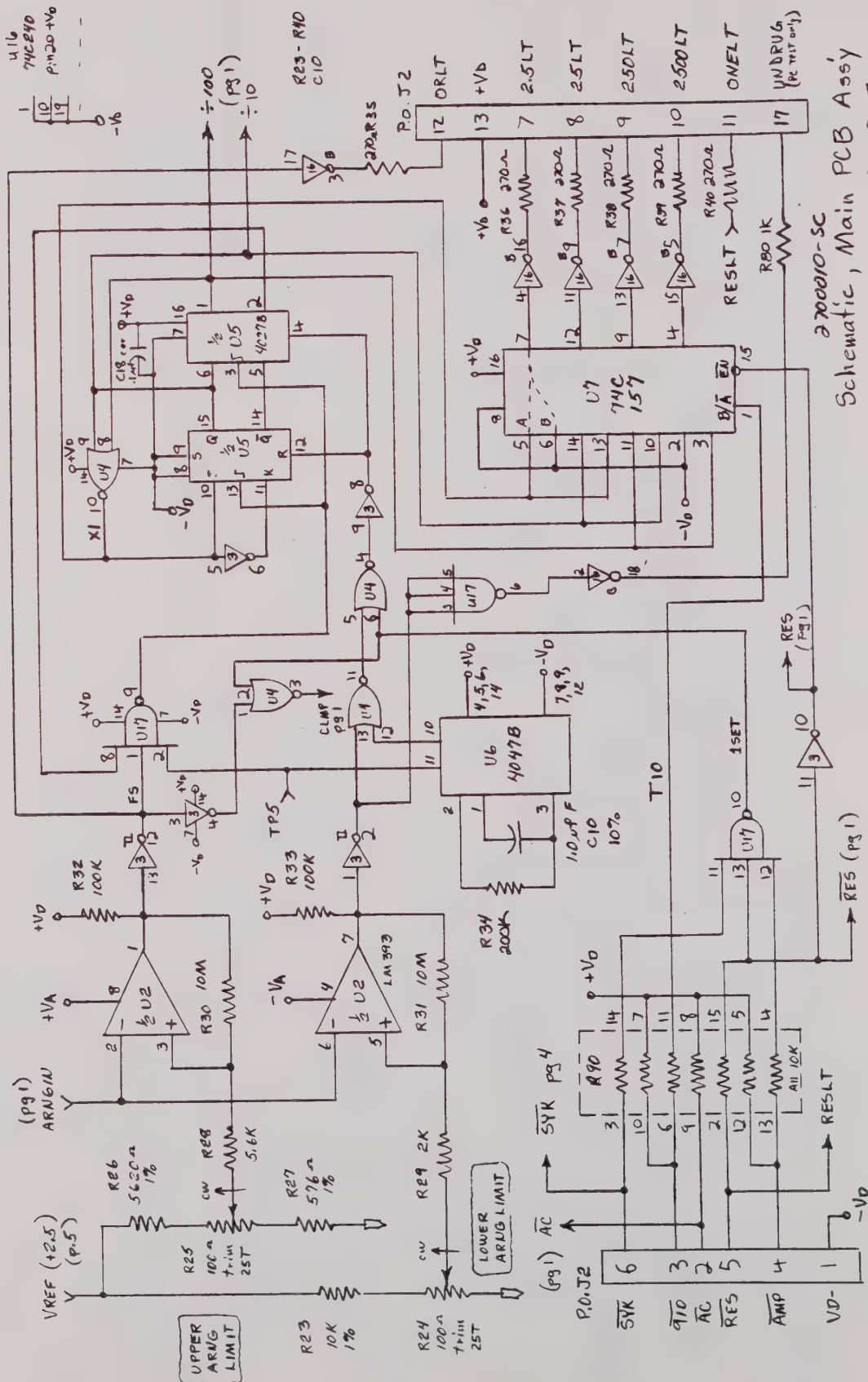
BLOCK DIAGRAM

Model 270
Block Diagram

W71 4/12/63

Auto Ranging Amplifier

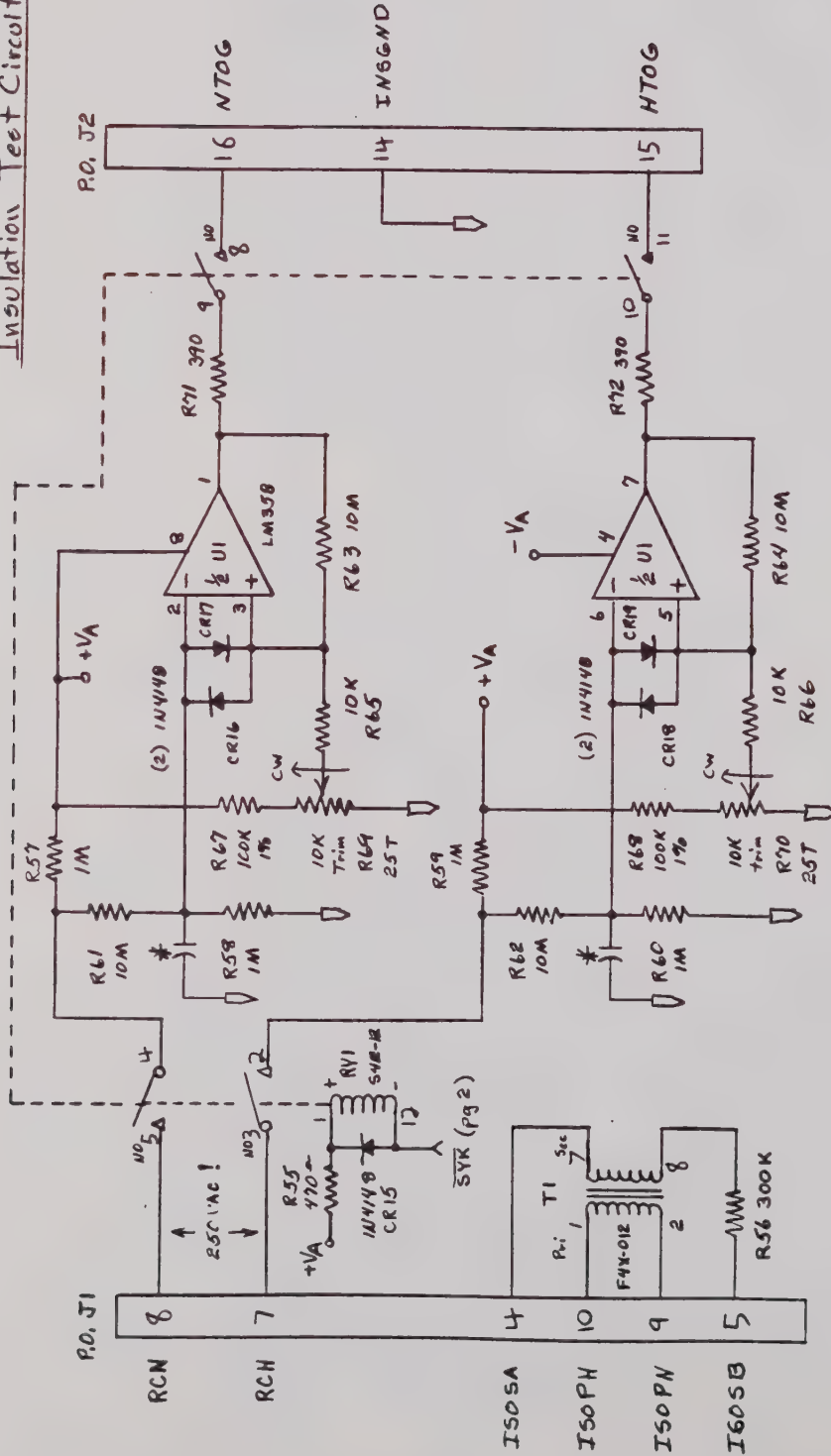




200010-SC
Schematic, Main PCB Assy
REV E pg 2 of 5

REV E pg 2 of 5

Insulation Test Circuit

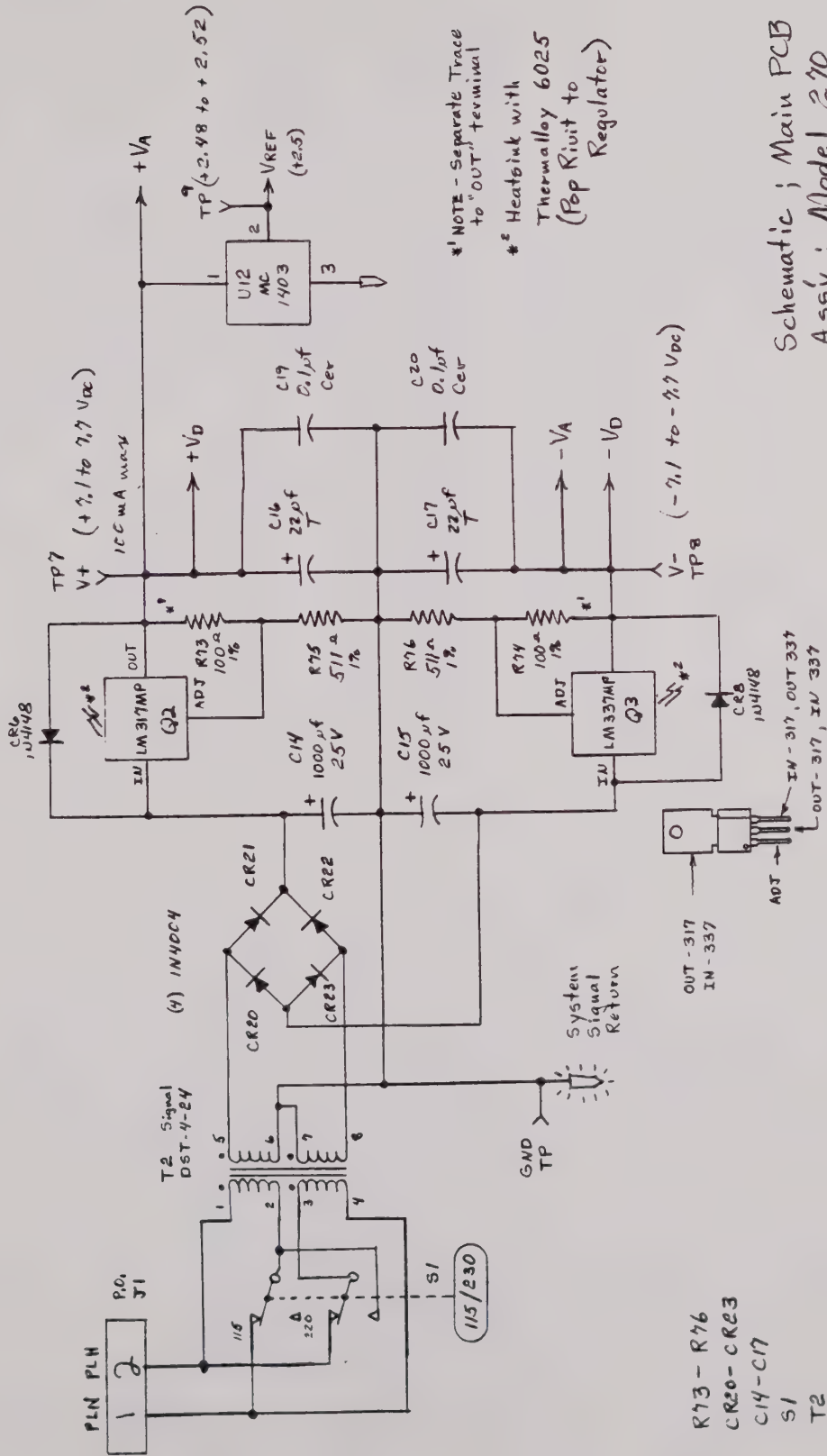


* Logos for ceramic cap on Q3" CC
(not presently tested)

R55 - R72
CR15 - CR19
T1
RY1

Schematic; Main PCB
Assy; Model 270
REV E pg 4 of 5
2700010-SC

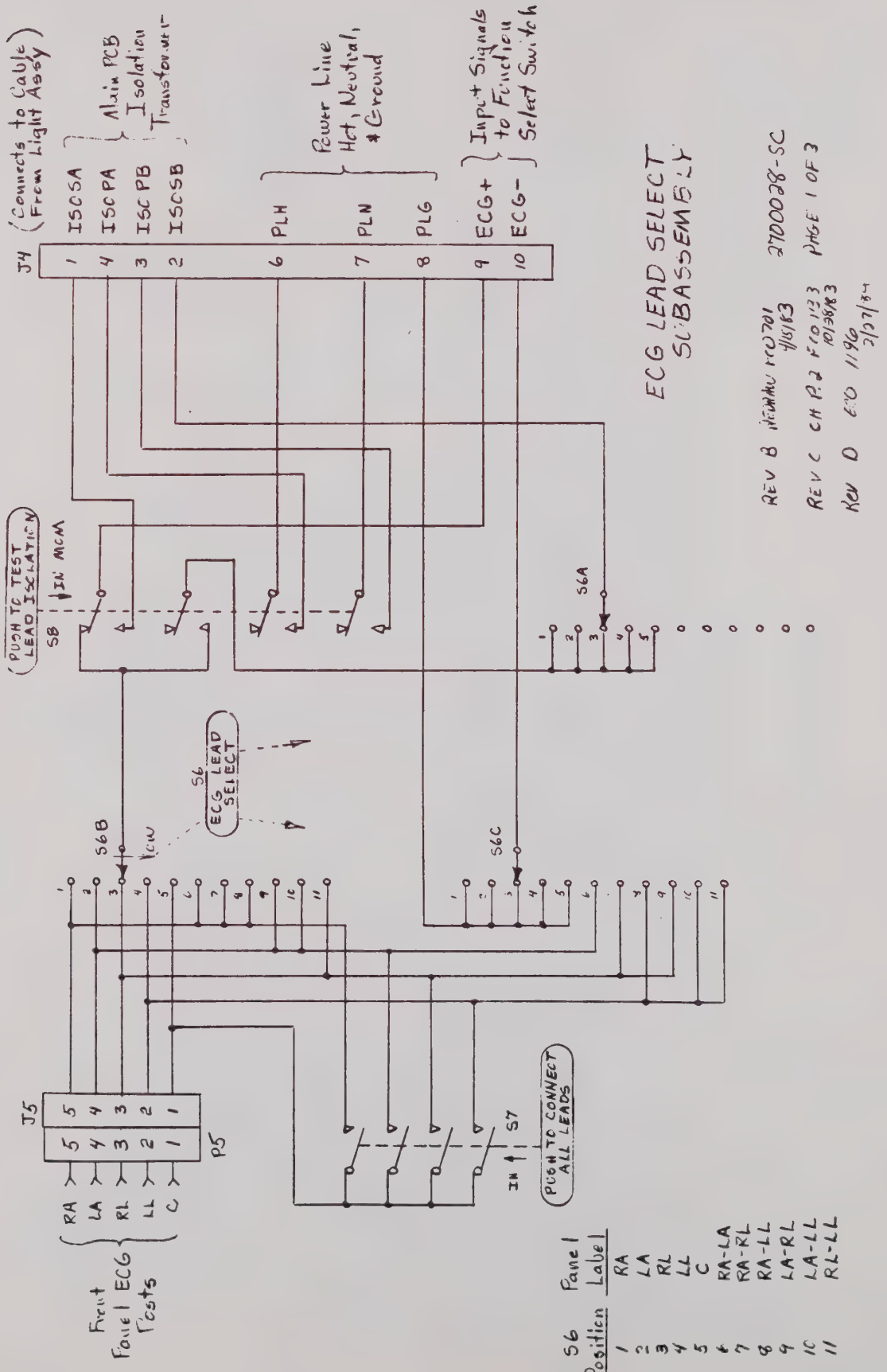
Power Supply-

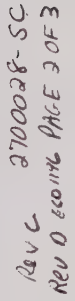


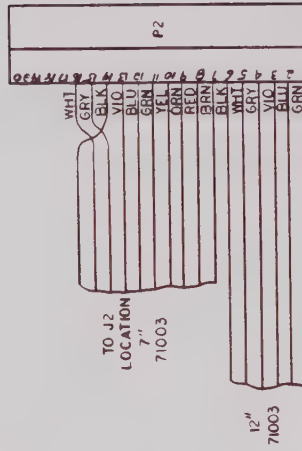
R73-R76
CR20-CR23
C14-C17
S1
T2

Schematic ; Main PCB
Assy ; Model 270

REV E pg 5 of 5
200010-5c

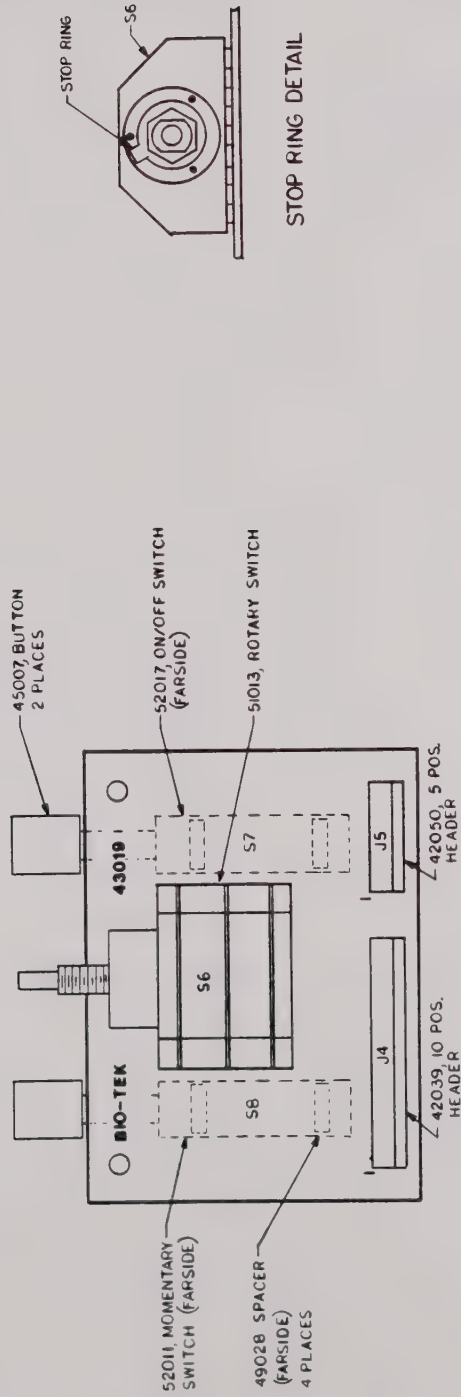




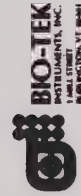


BIO-TEK
INSTRUMENTS, INC.
• 55 EAST WASHINGTON ST. •
• SUITE 100 •
• WILMINGTON, MA 01890 •
• TEL: (617) 850-1234 •
• FAX: (617) 850-1235 •

B	ADD R13	ECO 1133	DATE	14/31/12	APPROVAL		LIGHT ASSEMBLY SCALE 2 to 1 SHEET 1 OF 1 2700012-AS (ALL PARTS IN)
A	RELEASE TO PRODUCTION	ECO 1133	DATE	08/11/12	DRAWN	CHK #3	
REV	DESCRIPTION		DATE	BY	CHANGED		



STOP RING DETAIL



ECG SELECT PCB		DRAWING NO. 2700011-AS	
DATE 3/1/73	SCALE 1/1	SHEET 1 of 1	
APPROVALS	DATE	DRAWN BY	
DATE	DATE	CHECKED	
REV	DESCRIPTION	DATE	
A	RELEASE TO PRODUCTION ECG TEST	DATE	

PARTS LIST

12/10/84

BILL OF MATERIAL

KITTING LIST

2700010 270 FRONT PANEL ASBY

RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	C 5-21-84	9	.00
12006	SCR PAN 4-40x1/2 SS SLOT		4	4.00
12009	SCR PAN 6-32x3/4 SS SLOT		4	5.00
12011	SCR PAN 4-40x3/16 SS SLOT		4	2.00
14003	NUT HEX 4-40 STEEL		4	2.00
14007	NUT HEX 3/8		4	2.00
14009	NUT BEV 15/32 BLACK		4	4.00
15002	LOCKNUT 4-40 STEEL		4	5.00
16002	LKWSHR #4 HELICAL SPR SS		4	6.00
16009	LKWSHR #6 INT TOOTH STEEL		4	5.00
18014	WSHR FLANGED #6 NYLON		4	5.00
2700002	BRACKET 270 METER		1	1.00
2700008	SPACER 270 LED		1	1.00
2700009	PANEL 270 FRONT		1	1.00
2700011	270 PCB ASBY ECG SELECT		6	1.00
2700012	270 LIGHT ASSEMBLY		6	1.00
28016	VARISTOR	TS1	1	1.00
42018	SOCKET SAFETY LAB BLACK		2	1.00
42019	SOCKET SAFETY LAB RED		2	1.00
42025	CONN #8 SPADE, 14-16, INS		3	1.00

12/10/84

BILL OF MATERIAL

KITTING LIST

2700010 270 FRONT PANEL ASBY

RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
42034	CONN #6 RING, 22-18, INS		3	5.00
42036	CONN #6 RING, 14-16, INS		2	1.00
42053	CONN 14-16 FEM .250 INS		3	7.00
42056	TERM FEM Q-C 12-10 .250		3	2.00
42058	TIE CABLE 4" OR 3-3/8"		3	3.00
42071	CONN 5-PIN AUTO INS .156 P5		3	1.00
42080	TERM Q-C FEMALE 14-16 INS		3	2.00
42131	CONN HOUSING 10-P .100 FM P3		3	1.00
42132	TERM CRIMP .100 GOLD		3	10.00
44042	OVERLAY 270 FRONT		1	1.00
45014	KNOB POINTER 15MM BLUE		3	1.00
45032	KNOB CAP W/LINE 21MM BLUE		2	1.00
45033	KNOB W/ LINE 21MM BLACK		2	1.00
45034	KNOB CAP W/LINE 15MM BLUE		2	1.00
45035	KNOB W/ LINE 15MM BLACK		2	1.00
46016	FUSEHOLDER UNIVERSAL		2	1.00
46017	FUSECARRIER N AMERICAN		2	1.00
46019	FUSE 1/10A 250V GLASSTUBE		2	1.00
48041	ADAPTER ECG		3	5.00
48042	ADAPTER RETAINER ECG		3	5.00

12/10/84

BILL OF MATERIAL

KITTING LIST

2700010 270 FRONT PANEL ASBY

RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
49002	SPACER PLASTIC 1/4"L #4		3	2.00
49018	BRACKET RIGHT ANGLE		3	2.00
51004	SW ROT 10-POS 4-POLE	S5	1	1.00
52016	SW PB SPST W/ CAP	S9	1	1.00
52024	BUTTON GUARD BLK KNURLED		1	1.00
55001	SW TOGGLE SPST 15A	S3	2	1.00
55002	SW TOGGLE DPST 6A	S1	2	1.00
55003	SW TOGGLE DPDT 3-POS 20A	S4	2	1.00
55011	SW TOGGLE SPST MOM 15A	S2	2	1.00
71002	WIRE HOOK-UP 14 AWG	BLACK A/R	4	.00
71002	WIRE HOOK-UP 14 AWG	GREEN A/R	4	.00
71002	WIRE HOOK-UP 14 AWG	WHITE A/R	4	.00
71013	WIRE 1-COND 22 AWG	BLACK A/R	4	.00
71013	WIRE 1-COND 22 AWG	BROWN A/R	4	.00
71013	WIRE 1-COND 22 AWG	GREEN A/R	4	.00
71013	WIRE 1-COND 22 AWG	RED A/R	4	.00
71013	WIRE 1-COND 22 AWG	WHITE A/R	4	.00
71020	SHRINK TUBE 3/32"	A/R	4	.00
71033	CABLE RIBN TWISTED PAIR	A/R	4	.00
71034	CABLE RIBN 10-COND 22 AWG A/R		4	.00

12/10/84

BILL OF MATERIAL

KITTING LIST

2700010 270 FRONT PANEL ASBY

RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
7770018	RECEPT HOSPITAL DRILLED		1	1.00
7770020	SPACER ECG		1	1.00
92011	METER,0-1milliammeter		1	1.00

12/10/84

BILL OF MATERIAL

KITTING LIST

2700011 ~~270~~ PCB ASBY ECG SELECT RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	A	9	.00
14010	NUT HEX 1/4-32 SS 3/8AF		4	1.00
42039	HEADER 10-PIN .156	J4	2	1.00
42050	HEADER 5-PIN .156	J5	3	1.00
43019	PCB 270-ECG SELECT		1	1.00
45007	BUTTON RECT BLACK		2	2.00
49028	SPACER DOG BONE .093"H		3	4.00
51013	SW ROT 12-POS 3-POLE ADJ	S6	1	1.00
52011	SW PB 1-STA 4-POLE	S8	1	1.00
52017	SW PB 1-STA 4-POLE	S7	1	1.00

2700012 270 LIGHT ASSEMBLY RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	B	9	.00
01010	NEON LIGHT 70 VOLT	LN1-4	2	4.00
03001	LED GREEN	DS2-6	2	5.00
03006	LED TRI-STATE	DS7,8	2	2.00
03007	LED YELLOW	DS1	2	1.00
19003	RIVET POP 1/8D .060-.125G		4	2.00
31104	RES 100.0K OHM 5% 1/4W	R7	4	1.00
32030	RES 100.00K OHM 1% 1/4W	R5,8	4	2.00
32052	RES 2.00M OHM 1% 1/4W	R10,11,12	4	3.00
32061	RES 150.00K OHM 1% 1/4W	R2-4,13	4	4.00
33013	RES 1.00K OHM 1% 25W	R9	1	1.00

22032	DIODE TVS312 ZENER 12V 3W CR12		2	1.00
23003	IC 636 RMS-TO-DC CONVERTR U14		1	1.00
23016	OP AMP 747	U10,11	2	2.00
23021	VOLT REG +ADJ 1.5A 317	Q2	1	1.00
23022	VOLT REG -ADJ .5A 337	Q3	1	1.00
23027	OP AMP 358 DUAL	U1	1	1.00
23028	VOLT COMP LM393 DUAL	U2	1	1.00
23038	OP AMP LF411	U13,18	1	2.00
25001	IC 4066 QUAD SWITCH	U15	1	1.00
25003	IC 4001 NOR 2-IN QUAD	U4	1	1.00
25010	IC 4047 LP MONO/AS MUL	U6	1	1.00
25011	IC 4023 NAND 3-IN TRIPLE	U17	1	1.00
25022	IC 40106 HEX SCHMITT TRIG	U3	1	1.00

2700013 270 PCB ASBY

RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
25023	IC 4027 J-K FLIP-FLOP DL	U5	1	1.00
25049	IC 74C157 MULTIPL 2-IN QD	U7	1	1.00
25050	IC 74C240 TRI-ST INVERTER	U16	1	1.00
26002	TRANSISTOR 2N4123	Q1	1	1.00
2700006	ROD NYLON 1/8x3.5 (67144)	CUT AT PROD	4	1.00
2700007	SPACER 270 MACHINED		1	1.00
28004	VOLT REF 2.5	U12	1	1.00
31101	RES 100.0 OHM 5% 1/4W	R41,42,43	4	3.00
31102	RES 1.0K OHM 5% 1/4W	R80	4	1.00
31103	RES 10.0K OHM 5% 1/4W	R65,66	4	2.00
31103	RES 10.0K OHM 5% 1/4W	R9,12,15,50	4	4.00
31104	RES 100.0K OHM 5% 1/4W	R32,33	4	2.00

31105	RES	1.0M OHM 5% 1/4W	R57-60	4	4.00
31106	RES	10.0M OHM 5% 1/4W	R30,31,61-64	4	6.00
31133	RES	13.0K OHM 5% 1/4W	R53	4	1.00
31202	RES	2.0K OHM 5% 1/4W	R29	4	1.00
31203	RES	20.0K OHM 5% 1/4W	R13,21,22	4	3.00
31204	RES	200.0K OHM 5% 1/4W	R34	4	1.00
31271	RES	270.0 OHM 5% 1/4W	R35-40	4	6.00
31303	RES	30.0K OHM 5% 1/4W	R84	4	1.00
31304	RES	300.0K OHM 5% 1/4W	R56	4	1.00
31391	RES	390.0 OHM 5% 1/4W	R71,72	4	2.00
31432	RES	4.3K OHM 5% 1/4W	R11	4	1.00
31471	RES	470.0 OHM 5% 1/4W	R19,20,55	4	3.00
31512	RES	5.1K OHM 5% 1/4W	R51	4	1.00
31562	RES	5.6K OHM 5% 1/4W	R28,45	4	2.00
31683	RES	68.0K OHM 5% 1/4W	R46,47	4	2.00
31911	RES	910.0 OHM 5% 1/4W	R16	4	1.00
32030	RES	100.00K OHM 1% 1/4W	R67,68	4	2.00
32042	RES	10.00K OHM 1% 1/4W	R23,49,83	4	3.00
32045	RES	24.90K OHM 1% 1/4W	R6	4	1.00
32047	RES	1.00K OHM 1% 1/4W	R48	4	1.00
32100	RES	100.00 OHM 1% 1/4W	R73,74,91	4	3.00
32122	RES	226.00 OHM 1% 1/4W	R10	4	1.00
32127	RES	2.26K OHM 1% 1/4W	R5	4	1.00
32164	RES	340.00K OHM 1% 1/4W	R8	4	1.00
32174	RES	576.00 OHM 1% 1/4W	R27	4	1.00
32182	RES	511.00 OHM 1% 1/4W	R75,76	4	2.00
32190	RES	200.00K OHM 1% 1/4W	R14	4	1.00
32191	RES	5.62K OHM 1% 1/4W	R26	4	1.00

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
33005	RES 10.00 OHM 1% 1W MF	R1	1	1.00
33018	RES 100.00K OHM 1% 1W	R2	1	1.00
35006	TRIMPOT 5K, 25T	R44	2	1.00
35007	TRIMPOT 2K,25T	R17	2	1.00
35008	TRIMPOT 10K 25T	R81	2	1.00
35008	TRIMPOT 10K 25T	R7,54,69,70	2	4.00
35012	TRIMPOT 1K 25T	R4	2	1.00
35017	TRIMPOT 200 OHM, 25T	R18	2	1.00
35018	TRIMPOT 100 OHM, 25T	R24,25,77	2	3.00
36016	POT 1K OHM 1T 10%	R52	1	1.00
37013	RESNET 10K OHM 8R16P DIP	R90	1	1.00
42035	HEADER 20-PIN MALE LOCK	J2	2	1.00
42039	HEADER 10-PIN .156	J1	2	1.00
42130	HEADER 10-PIN GOLD	J3	2	1.00
43013	PCB 270 MAIN		1	1.00
49014	TERM PCB		3	10.00
49090	HEATSINK PC MOUNT TO-220		2	2.00
53007	SW SLIDE DPDT	S1	1	1.00
61002	TRANSF 115/230 24V-CT	T2	1	1.00
61004	TRANSF ISOL ALL V	T1	1	1.00
62003	RELAY 4PST	RY1	1	1.00
62004	RELAY 5V 1A REED	RY2,3	1	2.00
81009	CAP 100 uF 25V ELEC	C14,15	2	2.00
82001	CAP 4.7 uF 10V TANT	C7,8,9	2	3.00
82004	CAP 22 uF 15V TANT	C16,17	2	2.00
82005	CAP 1 uF 35V TANT	C6	2	1.00
82006	CAP 2.2 uF 35V TANT	C23,24	2	2.00
82011	CAP 4.7 uF 35V TANT	C13	2	1.00

83001	CAP	33 pF	DISC C2	3	1.00
83009	CAP	.1 uF	12V DISC C26	3	1.00
83019	CAP	.1 uF	100V DISC C3,4,18-22	3	7.00
84002	CAP	.1 uF	100V FILM C5	1	1.00
84009	CAP	1 uF	100V FILM C10,11	1	2.00
84010	CAP	.68 uF	35V MYLR C12	1	1.00
84014	CAP	1 uF	400V POLY C25	1	1.00
85001	CAP	.15 uF	600V 5% C1	1	1.00

2700014 270 BACK PANEL ASBY RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	H 12-10-84	9	.00
12022	SCR PAN 6-32x1/4 SS SLOT		4	8.00
16003	LKWSHR #6 HELICAL SPR SS		4	8.00
17007	WSHR FLAT 3/4 ID SS		4	1.00
19006	RIVET POP AL HEAD/ST SHNK		4	4.00
2700005	PANEL 270 BACK		1	1.00
2700013	270 PCB ASBY		6	1.00
42004	JACK BANANA GREEN		3	1.00
42008	PLUG HOSPITAL GRADE MALE		2	1.00
42027	CONN #8 RING, 16-14, INS		3	1.00
42028	CONN EXTERNAL POST		3	1.00
42036	CONN #6 RING, 14-16, INS		2	1.00
42069	CONN #8 SPADE 22-18		3	1.00
42079	TERM Q-C FEMALE 18-22 INS		3	2.00
42080	TERM Q-C FEMALE 14-16 INS		3	2.00
42086	TERM .250 18-22AWG INS QD		3	2.00

44033	OVERLAY 270 REAR PANEL	1	1.00
46001	FUSE 1/4A 3AB W/ BOX	3	2.00
46007	FUSE 15A SLOW BLOW	3	2.00
46020	FUSEHOLDER INTNATL HI-PRO	2	4.00
46021	FUSECARRIER N AMER SLOT	2	4.00
49019	STRAINRELIEF FOR SJT 14/3	3	1.00
49032	CORDWRAP PLASTIC BLACK	PCS,NOT PAIR	2 4.00
71001	POWERCORD 14/3 SJTO	4	6.00
71002	WIRE HOOK-UP 14 AWG	GREEN A/R	4 .00
71005	WIRE HOOK-UP 22 AWG	BLACK A/R	4 .00
71005	WIRE HOOK-UP 22 AWG	GREEN A/R	4 .00
71005	WIRE HOOK-UP 22 AWG	WHITE A/R	4 .00
71035	SHRINK TUBE 1/4"	A/R	4 .00

2700015	270 CASE ASSEMBLY	RUN #	QTY:	1
---------	-------------------	-------	------	---

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY	EXT	ISSUES
*	*** REVISION LEVEL ***	C 12-04-85	99	.00	.00	
12027	SCR PAN 10-32x5/8 SS SLOT		4	2.00	2.00	
16011	LKWSHR #10 INT TOOTH SZ		4	2.00	2.00	
19004	SCR PAN #6x1/2 ST #2PHIL		4	4.00	4.00	
19008	RIVET POP AL HEAD/ST SHNK		4	4.00	4.00	
2700003	BEZEL 270 LONG	* PCS,NOT PAIR	9	2.00	2.00	
2700004	CASE 270		9	1.00	1.00	
2700034	CASE 270 BOTTOM		9	1.00	1.00	
44016	BEZEL SHORT BLACK	PCS,NOT PAIR	2	2.00	2.00	
44067	FOOT RUBBER BLACK		4	4.00	4.00	
44140	ACCESSORY POUCH 270		2	1.00	1.00	
49026	HANDLE		2	1.00	1.00	
49153	FASTENER MALE SNAP		1	4.00	4.00	

12/19/85

BILL OF MATERIAL

KITTING LIST

2700016 270 ACCESSORIES

RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	G 11-26-85	99	.00
46001	FUSE 1/4A 3AB W/ BOX		3	2.00
46004	FUSE 10A 250V 3AB W/ BOX		3	2.00
46007	FUSE 15A SLOW BLOW		3	2.00
46018	FUSECARRIER INTERNATIONAL		3	1.00
46019	FUSE 1/10A 250V GLASSTUBE		3	1.00
46022	FUSECARRIER INTNATL SLOT		3	4.00
48002	CLAMP PIGMY HIPPO		3	1.00
48004	ADAPTER BULLET GROUND		3	1.00
48005	ADAPTER GROUND		3	1.00
48031	PROBE TEST RED		2	1.00
48032	LEAD LAB TEST 5' BLACK		1	1.00
48033	LEAD LAB TEST 5' RED		1	1.00

2700017 270 FINAL ASSEMBLY RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	D 12-10-84	9	.00
12011	SCR PAN 4-40x3/16 SS SLOT		4	2.00
2700007	SPACER 270 MACHINED		1	1.00
2700010	270 FRONT PANEL ASBY		6	1.00
2700014	270 BACK PANEL ASBY		6	1.00
2700015	270 CASE ASSEMBLY		6	1.00
2700016	270 ACCESSORIES		6	1.00
2700033	270 SHIPPING LIST		6	1.00
45008	KNOB BLACK 11MM		2	1.00
45011	KNOB CAP BLUE FOR 11MM		3	1.00
66004	LOKTITE 50CC	A/R	4	.00
67144	NYLON ROD 1/8" DIA	3"	1	.25

2700033 270 SHIPPING LIST RUN #

PART #	DESCRIPTION	REFERENCE	MEMO CODE	QTY
*	*** REVISION LEVEL ***	B 06-20-85	99	.00
91052	BOX 270		45	1.00
91053	FOAM PKG 270 ENDCAP		45	2.00
94001	CARD WARRANTY REPLY		4	1.00
94035	MANUAL 270		2	1.00
98022	CERTIF OF COMPL & CALIB		47	1.00

QUESTIONNAIRE

It is important to us at Bio-Tek to hear what our customers have to say about our product and the manual. After familiarizing yourself with the product and the manual, please answer the questions below. When you have finished our questionnaire, detach and mail it to us postage prepaid.

1. For which Bio-Tek product are you answering this questionnaire?

8. What additional features would you like the unit to have?

2. How extensively have you used the unit?

9. Should any changes be made to the manual?

3. What additional features or tests would you like the unit to have?

10. Did you find the manual helpful?

4. Did you read this manual before operating the unit for the first time?

11. Were the instructions clear and easy to follow?

5. How often and under what conditions do you refer to this manual?

12. How does the manual compare to other manuals you have used?

6. Does the manual completely describe the operational procedures?

13. How can we improve the manual?

7. Does the manual provide sufficient information to understand how the unit works?



ut our products and our
please take the time to
ach this form and mail it to

onal information should be included in the manual?

thing now in the manual be omitted?

d any errors? If so, please specify below.

verlays on the unit itself clear and helpful?

his manual compare with operator's manuals for other
ers' equipment you have used?

e improve this manual?

